FINAL REPORT

HABITAT EVALUATION OF LESSER PRAIRIE CHICKENS IN EASTERN CHAVES COUNTY, NEW MEXICO

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FROM

DEPARTMENT OF FISHERY AND WILDLIFE SCIENCES

NEW MEXICO STATE UNIVERSITY, AGRICULTURAL EXPERIMENT STATION

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The New Mexico Department of Game and Fish provided permits to trap, band, and collect prairie chickens, as well as the use of mist nets which were essential to trapping success. Bitter Lake National Wildlife Refuge, U.S. Fish and Wildlife Service, provided cannon and rocket nets which also were essential to trapping success.

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C. A. Davis, T. Z. Riley, R. A. Smith, H. R. Suminski, and M. J. Wisdom[1]

The lesser prairie chicken (Figs. 1, 2, 3) occupies a restricted geographic range in parts of eastern New Mexico, western Texas, western Oklahoma, southwestern Kansas, and southeastern Colorado. Numbers and range of the speices are much reduced in comparison with presettlement times, apparently in response to prolonged heavy grazing and brush control in combination with the great drouths of the 1930's and 1950's (Hamerstrom and Hamerstron 1961). In New Mexico, they occupy approximately one half their original range (New Mexico Dept. Game and Fish 1967).

The Bureau of Land Management, U.S. Department of Interior, administers public lands which occupy a large part of the lesser prairie chicken's range in New Mexico and, therefore, is responsible for managing most of the species' habitat in the state. However, relatively little information is available which describes the habitat needs and tolerances of prairie chickens in New Mexico. Frary (1957) conducted a generalized study of lesser prairie chicken habitat areas owned by the New Mexico Department of Game and Fish in eastern New Mexico, and Crawford (1974) studied foods and habitat types used by the species in western Texas. Other literature on habitat of lesser prairie chickens, applicable to New Mexico, is restricted to accounts of casual observations (Bailey 1928, Ligon 1961).

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[1]Professor and graduate research assistants in the Department of Fishery and Wildlife Sciences.

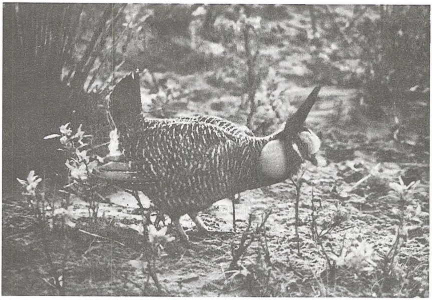

Figure 1. Male lesser prairie chicken displaying.

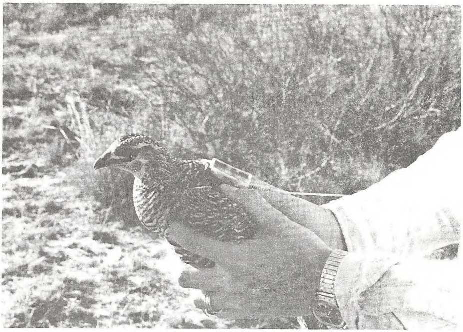

Figure 2. Female lesser prairie chicken fitted with solar-recharging radio transmitter.

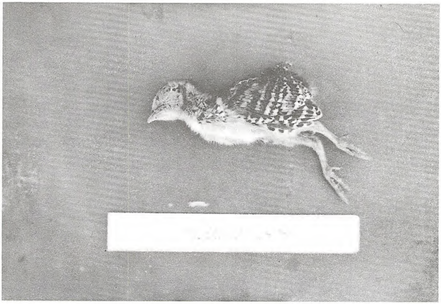

Figure 3. Young lesser prairie chicken, with natal down on body, juvenile feathers on wings.

Because of the lack of information described above, this study was undertaken (as stated in contracts between the Bureau and New Mexico State University) to provide the Bureau with adequate knowledge to evaluate the effects of livestock grazing on lesser prairie chicken habitat needs in eastern New Mexico. Contract objectives were:

(1) To develop acceptable standard methods of evaluating the vegetative components of lesser prairie chicken habitat in eastern New Mexico.

(2) To determine the vegetative characteristics of nesting, brood-rearing and other seasonally occupied habitat through the observation of lesser prairie chickens including radio telemetry equipped chickens.

(3) To develop management recommendations with supporting documentation in terms of vegetative goals for specified habitat features including the spatial requirements of these goals, with respect to expansion, improvement, or maintenance of the vegetative components that would result in a secure population of lesser prairie chickens.

(4) To update a listing of literature citings and knowledgeable individuals which may be consulted for further information and recommendations concerning the species in question.

The first objective was met by development of the methods described in this report. The second third objectives are met by the results, discussion, and management recommendations of this report, and the fourth is met by the inclusion of Appendix I.

The study was conducted on public lands in the Mescalero Sands area, north of U.S. Highway 380, in eastern Chaves County. The basic methods of study (see objective No. 1) were developed in fall and winter of 1975-76, and field work was conducted from January 1976 to August 1978. Davis directed the study, and participated in field work intermittently throughout the study. Principal field periods for graduate research assistants were as follows:

January to May 1976: Suminski (full-time).

June to August 1976: Suminski and Riley (full-time).

September 1976 to January 1977: Suminski and Riley (intermittent).

February to May 1977: Suminski (intermittent) and Riley (full-time).

June to August 1977: Riley and Smith (full-time).

September-December 1977: Smith (full-time).

January-May 1978: Smith (intermittent) and Wisdom (full-time).

June-August 1978: Smith and Wisdom (full-time).

STUDY AREA

The study area (Fig. 4) is in the East Chaves Planning Unit of the Roswell, New Mexico District of the Bureau of Land Management. The area is approximately 40 miles (64 km) east of Roswell, and lies north of U.S. Highway 380 and south of U.S. 70. Topography is mostly undulating and duny.

Vegetation of the area includes two principal types: The Shinnery Oak[2]-Tallgrass type occurs on the duny, sandy soils which occupy most of the area, and the Mesquite-Shortgrass type occurs in the flat expanses of tighter soils (Fig. 4). The Shinnery Oak-Tallgrass type includes three obvious subtypes (Figs. 5, 6, 7) which are distinguished primarily by relative quantities of sand bluestem; it declines in quantity from Subtype 1 through Subtype 3. The Mesquite-Shortgrass type (Fig. 8) is basically a grama grassland which has been invaded, to various degrees in various places, by mesquite.

Principal use of the area is for grazing by cattle. The area also is subjected to extensive and continuing exploration and development for production of gas and oil. This activity is known to have eliminated use of two leks ("booming grounds") and severely disrupted use of another, during the study.

Climate of the area (Maker et al. 1971) is semi-arid and characterized by distinct seasons, wide ranges of diurnal and annual temperatures, and plentiful sunshine. Temperatures of 90 degrees F. or higher occur on most days from mid-May through mid-September, and temperatures above 100 are common from June through August. Nighttime low temperatures generally are about 30 degrees cooler. Nearly three-fourths of the

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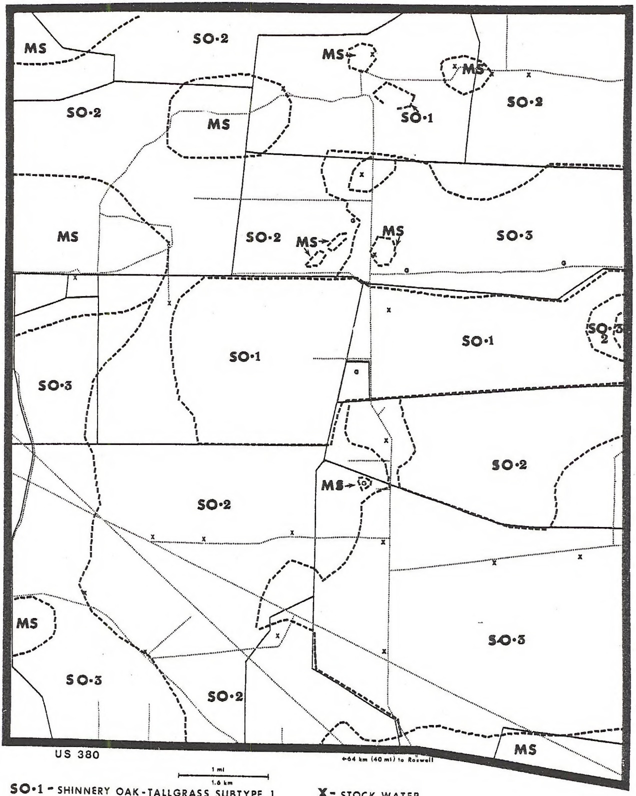
[2]Scientific names of plants are given in Appendix II.



SO·1 - SHINNERY OAK-TALLGRASS, SUBTYPE 1
SO·2 - SHINNERY OAK-TALLGRASS, SUBTYPE 2
SO·3 - SHINNERY OAK-TALLGRASS, SUBTYPE 3
MS - MESQUITE-SHORTGRASS

X - STOCK WATER
G - GAME WATER
— FENCES
---- ROADS

Figure 4. The study area, in eastern Chaves County, New Mexico.

Figure 5. Subtype 1 of the Shinnery Oak-Tallgrass vegetation type (prime nesting habitat). Most of the grass visible is sand bluestem.

Figure 6. Subtype 2 of the Shinnery Oak-Tallgrass vegetation type. Most grass visible is little bluestem.

Figure 7. Subtype 3 of the Shinnery Oak-Tallgrass vegetation type. Both sand bluestem and little bluestem are scarce.

Figure 8. The Mesquite-Shortgrass vegetation type showing displaying male prairie chicken, typical grasses, snakeweed (behind bird), and mesquite (far right).

annual precipitation (average, 13.6 in.) falls during May-October, mostly from brief but often intense thunderstorms.

Temperatures and precipitation at Maljamar, New Mexico (approximately 36 miles south of the study area) are shown in Figs. 9 and 10. Possible effects of some of the yearly differences during the study are discussed later.

The study area is occupied by numerous vertebrates in addition to the lesser prairie chickens. Common birds include the turkey vulture,[3] marsh hawk, Swainson's hawk, sparrow-hawk, scaled quail, mourning dove, roadrunner, burrowing owl, common nighthawk, meadowlark, and loggerhead shrike. Mammals observed most frequently are the pronghorn antelope, coyote, blacktailed jackrabbit, and spotted ground squirrel. A large black-tailed prairie dog town is present in the northwestern part of the area. Common reptiles include three rattlesnakes (prairie, diamondback, and massasauga) and several species of lizards, mostly whiptails.

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[3]Scientific names of vertebrates are given in Appendix III.

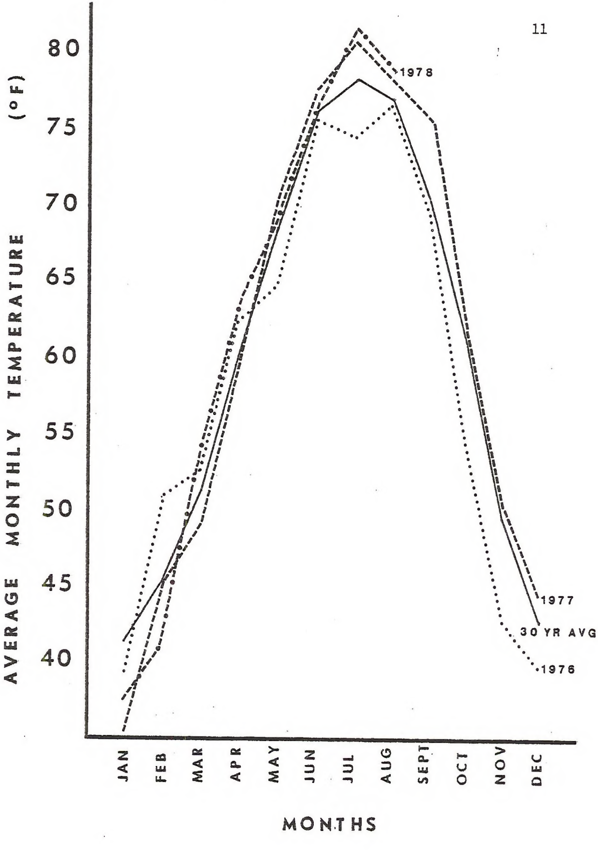

Figure 9. Average monthly temperatures at Maljamar, New Mexico, during the study.

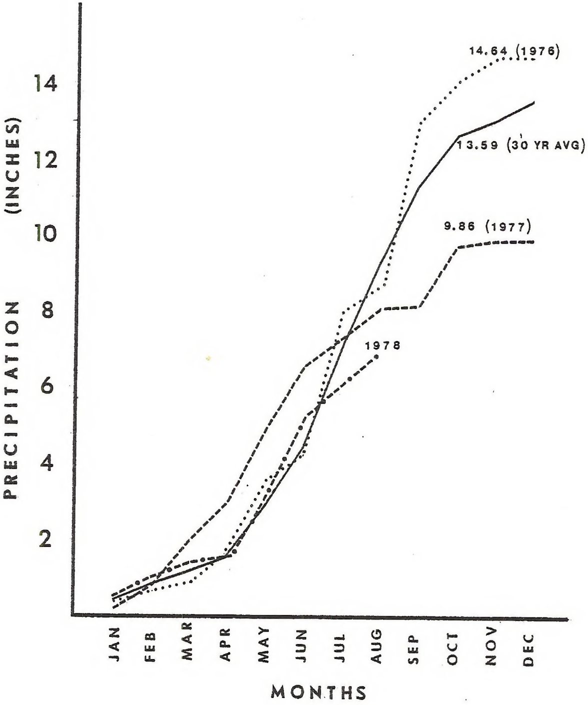

Figure 10. Cumulative annual precipitation at Maljamar, New Mexico, during the study.

METHODS

Trapping and Handling Prairie Chickens

Birds were trapped for telemetry work in springs (mostly early and mid-April) of 1976-78 and in fall (October) 1977. Spring trapping was to provide females for study of nesting, and fall trapping was to provide birds of both sexes for study of habitat-use. In springs of 1976 and 1977, most work was done with mist nets as described by Campbell (1972). Typically, the nets were erected across leks, and observers (up to four) waited in blinds about 30 feet from the net and attempted to flush individual females into the net. Sex of most birds could be determined readily by observation from the blinds (Campbell 1972). Due to the small number of females visiting the leks in any one day, and their wary behavior, this procedure was relatively unproductive. Few females visiting a lek approached the net, and most of those which came near the net could not be captured. When flushed, they often flew around or over the net. In addition, females which struck the net were much more adept at avoiding entanglement than were males. Best success with mist nets was in the dry spring of 1976. At each of several livestock water troughs adjacent to leks, one panel of mist net (20 ft wide) was erected in a V-shape with the trough inside the V. One or two observers waited in blinds and flushed birds from the trough into the net.

In spring 1976, one cannon net was used, along with the mist nets. In spring 1977, a rocket net also was used. In fall 1977 and spring 1978, only cannon and rocket nets were used. The rocket nets were slightly superior to cannon nets, due to greater speed of the rockets; no birds were able to fly from under these nets while they were settling to the

ground. Both cannon and rocket nets were vastly superior to mist nets, although occasionally a bird escaped the cannon net. One reason for the greater success of the cannon and rocket nets was that birds virtually ignored the folded net lying on the ground. Conversely, an erect mist net, especially when flapping in the wind, was readily observed and usually avoided by the birds. Cannon and rocket nets also were easily and quickly handled by one person, and required little maintenance or repair. Mist nets required much time for erecting, taking down, protection from cattle, and repair of broken strands.

Captured birds were held in large sacks, usually for only brief periods, until they could be processed. The darkness inside the sack usually was sufficient to keep the birds calm. The bird and sack were weighed together, and then the weight of the sack was subtracted from the total to yield the weight of the bird. They were examined for sex and age (Campbell 1972) and banded with numbered metal leg bands. Individuals to be radio-tracked were processed inside the cab of a truck to avoid the possibility of their escape while being fitted with the transmitter package. A large sock was used as a hood for these birds during processing; most of them thus remained calm while being handled.

Radio Telemetry

In 1976, radio equipment obtained from Electronics Specialties of Esko, Minnesota was used. The transmitter package was of the conventional type (Brander and Cochran 1969:99) with transmitter resting on the bird's back and battery resting on the breast. The insulated wires connecting battery and transmitter passed completely around the neck and under both wings, thus holding the entire package securely on the bird.

This stability of the transmitter attachment to the bird was a definite advantage, as was the strong signal and, therefore, the relatively long range of these transmitters. Disadvantages included the ease with which wires in the transmitter package came loose (e.g., bird attacked by predator), and the somewhat unpredictable length of battery life. Also, the portable receiver provided for use with these transmitters was somewhat inconvenient to carry in the field because of its size.

In 1977 and 1978, radio equipment from Wildlife Materials, Inc. was used. The transmitter and battery were sealed together in one package which was held on the back by a cord or band which passed around both shoulders exactly like that of a hiker's backpack. Solar panels were included with the battery, so that sunlight, even when dim, recharged the batteries daily. This capability provided extended battery life, in comparison with the batteries used in 1976. However, the range of the solar-charged transmitters was somewhat less than that of the earlier transmitters. Loss of the transmitter also was more common with the backpack transmitters but this difficulty was partly offset by the fact that these transmitters (having no exposed wires) usually continued to operate and, therefore, could be recovered for later use. The receiver used with the backpack transmitter also was smaller and more truly portable than the one used earlier.

Birds carrying transmitters were relocated regularly, in order to find nest sites and other daily activity (foraging, resting, roosting) sites. The usual procedure was to make initial radio contact with a bird while driving through the area in a truck having the portable receiver inside, and an antenna mounted on the cab. From the point of initial

contact, the observer walked toward the bird (its direction indicated by the strength of the radio signal) with the receiver and a hand-held antenna. When only the approximate location of the bird was desired (as with females just prior to nesting), direction to the bird was determined from two or more points and the bird was not approached closely. All locations were plotted on overlays of aerial photographs, for later use in determining approximate distances moved and vegetation types used. Sometimes, it was necessary to determine the exact location of a bird, while also minimizing disturbance. In these instances, the approximate location was noted from a distance, as described above. The observer returned later in the day, if the bird had moved away, and found the exact location by searching for tracks and droppings.

Identifying Vegetation Types and Subtypes

Preliminary identification of vegetation communities ("types") was based on field reconnaissance, in conjunction with study of aerial photographs. The difference between Mesquite-Shortgrass and Shinnery Oak-Tallgrass was obvious at the outset, and there remained the problem of distinguishing among subtypes of each of these. Although some variation in the Mesquite-Shortgrass type was apparent, this variation seemed unimportant to the chickens. They made little use of this type (only for leks) and where they did use it, its variation obviously made no difference. We sampled this type but (on the advice of the COAR), due to other priorities made no attempt to recognize or sample its subtypes.

Field reconnaissance suggested that four subtypes of Shinnery Oak-Tallgrass were present. Line-point transects (described below) were

scattered over the area and data collected from them were stratified into four groups representing the four apparent subtypes. A preliminary analysis of the data, along with informal comparison of data from individual transects, required combining two of the four proposed subtypes and realigning several preliminary subtype boundaries on the map.

Data used to characterize vegetation types and subtypes were collected from line-point transects. Each transect was in the shape of an X, with arms extending north, south, east, and west from the center point. The observer walked, on each arm, 100 steps from the center point, and used the toe of the right boot as the data point. Thus, each arm contributed 50 data points, and the entire transect had 200 points. Cover (bare ground, litter, or live plant base) was recorded for each point; the species of the plant with its base on the point also was recorded. At points where no live plant stem was present, the name of the nearest live plant ahead of the toe was recorded. Data were summarized and analyzed by standard statistical methods which are cited in the section of this report containing the results. The data summaries were used to describe the two vegetation types, and the subtypes of Shinnery Oak-Tallgrass, in terms of mean percent species composition and ground cover (percent live plant, litter, and bare ground).

Determining Use of Types and Subtypes

Nests were found by use of radio telemetry (33 nests) and, in a few cases (4 nests), by accident. The vegetation type and subtype in which each was located was recorded. Later, the number of nests found in each subtype of Shinnery Oak-Tallgrass (none were found in Mesquite-Shortgrass) was compared statistically with the number to be expected if nest placement

had been random.

Use of radio telemetry, the principal method for finding nests, proved inadequate for finding sufficient broods for study. This was due to the small sample size inherent in telemetry studies, aggravated by low nesting success -- very few of the radio-equipped females produced broods; therefore very few broods were available for radio contact. In 1976, we experimented with cross-country transects to find broods. This method showed promise and, therefore, was developed so that it produced usable results in 1977 and 1978. It required traversing the area once during mid-summer, at half-mile intervals, while searching for broods. Each encounter with either a brood or brood sign (tracks, droppings) was recorded and classified according to the type/subtype where it occurred. Relative use of each type/subtype by broods then was computed as number of encounters per linear mile of transect.

Experimental walking of cross-country transects, started in work with broods in summer 1976, also was carried out in that fall. As with the 1976 brood-transects, the method appeared workable but required a larger sample. Therefore, in winter of 1977-78, transects were established at half-mile intervals across the area from east to west. Each transect was traversed on horseback once during January 19 to Febuary 16. Each encounter with either chickens or their sign was recorded and classified according to the type/subtype where it occurred. Relative use of each type/subtype then was computed as number of encounters per linear mile of transect. Numbers of encounters with radio-equipped birds also was recorded for each type/subtype.

Describing Daily Activity Sites

Nests and foraging, resting, and nighttime roosting sites were found by use of radio telemetry, while traversing the area censusing chickens, and while doing other work. Most nests were identified as those of prairie chickens by the presence of the female. A few, those not used by radio-equipped females, were identified by the presence of typical prairie chicken eggs, tracks,and/or feathers. Foraging sites were indicated by numerous scattered tracks and droppings, signs of pecking and scratching, and remains of partly eaten plant material. Resting and nighttime roosting sites were identified by small piles of droppings indicating that the bird sat in the same place for some time.

Data used to describe daily activity sites in spring and summer were taken from compact, multi-armed transects. These transects had eight arms extending outward (north, northeast, east, etc.) 10 feet from the center point, which was placed in the center of the activity site. Data points were at one-foot intervals, so that each arm provided 10 points, and the entire transect had 80 points. As on the large transects used to sample types/subtypes, cover (live plant base, litter, bare) was recorded at each point, as was the name of the plant with its base on the point; where no live plant base was present on the point, the name of the nearest live plant ahead of the point was recorded. Height was measured for the plant (live or dead) nearest the center of the transect and for the plant (live or dead) nearest each third data point on each arm of the transect.

Data used to describe roosting/resting sites in fall and winter were taken from eight-arm, line-point transects exactly like those used at all (nesting, foraging, resting, roosting) activity sites in spring and summer. Data describing fall-winter foraging sites were taken from larger transects, due to the extensive movements of foraging birds. These transects consisted of four arms extending (north, east, etc.) 50 steps from the center of the identified foraging area. The observer walked along each arm, with the toe of the right boot as the data point (25 points per arm, 100 per transect). At each point, cover (bare ground, litter, or live plant base) was recorded; the plant species with its base on the point also was recorded. Where no live stem was on the point, the nearest live plant ahead of the point was recorded. At each third point, the height of the nearest of one of three grasses (sand bluestem, little bluestem, sand dropseed) was measured.

Height and percent livestock utilization of 24 randomly selected individuals (each) of sand bluestem, little bluestem, and dropseed were taken from the area within 30 ft of each nest. Where fewer than 24 individuals were present, the sample was considered complete when it included all individuals present. Height was measured directly, and percent utilization was derived from the height-weight relationships of the indivdual species; this method is described in detail by Crafts (1938) and Pieper (1978).

Data from daily activity sites were analyzed statistically, to characterize vegetation at each kind of site in terms of mean percent species composition, ground cover (percent live plant, litter, and bare), and height. For the area within 30 feet of nests, the data also showed

mean height and percent livestock utilization of sand bluestem, little bluestem, and dropseeds.

Evaluating Nest Success

A nest was considered successful when at least one egg in the clutch hatched. Evidence of nesting success was verified either by observation of chicks accompanying the radio-equipped female which used the nest or by observation of characteristic hatched shells (shell empty, open at large end, with end of shell inverted inside) at the nest site.

When possible, cause of nest failure was determined. A nest was considered abandoned if the female remained away from her nest, even though a full or partial clutch was intact (no apparent nest predation). Nest predation was determined by missing and/or crushed eggs and other characteristic predator sign.

Skunks typically tore the nest entirely apart, leaving broken egg shells mixed in the remains of the nest lining. Generally the depression beneath the nest was extensively dug out, and tracks and claw marks were abundant.

Coyote nest predation was similar, except that digging around the nest was not extensive, and sometimes the nest lining and depression were undisturbed. Crushed egg shells were always observed scattered in and around the nest site.

Evidence of snake predation was entirely different. Little or no direct sign was apparent. The nest was undisturbed, with all eggs invariable missing. No egg shells or other egg remains were ever observed, no doubt resulting from the snake swallowing the eggs whole.

Other predators may have destroyed nests, but little diagnostic sign remained when the nest was observed. These nests were classified as either mammal or unknown predator. Observations of the nest predator habits described herein are in general agreement with Rearden (1951) and Sooter (1946).

Determining Food Habits

Crop contents were taken from prairie chickens shot in all seasons. A few birds were taken from leks, but most were taken from sites scattered in the three subtypes of Shinnery Oak-Grassland. In early December 1977, crop contents were donated by several hunters. In summer, some smaller chicks were caught by hand and, in spring, crop contents were taken from the few birds which died in the nets. Also, crop contents were salvaged from one male killed on a lek by a Cooper's hawk. Foods from crops were identified by comparison with plants and plant parts from the study area, and with pictures and printed descriptins of plants and animals.

Composition of the diet was computed for each season by the aggregate percent method (Martin et al. 1946). Percent composition of the contents of each crop were calculated from volumetric (water displacement) measurements, and the mean percent that each kind of food contributed to the seasonal diet was computed by averaging percent values of that food from all crops taken during that season.

USE OF VEGETATION TYPES AND SUBTYPES

Vegetation of the subtypes of the Shinnery Oak-Tallgrass type is described in Table 1. Subtype 1 is dominated by grasses, especially sand bluestem, and shinnery oak. Subtypes 2 and 3 have progressively less sand bluestem, and subtype 3 also is more brushy than the other subtypes. Data in Table 2 describe the grass and shrub composition of the above subtypes, without reference to forbs; these data are compared with data from foraging areas later. The Mesquite-Shortgrass type (Table 3) is dominated by blue grama and buffalo grass; in many shortgrass areas, mesquite is the most conspicuous shrub, although it is insignificant in the overall composition. The Mesquite-Shortgrass type has more plant cover and less litter than does the Shinnery Oak-Tallgrass type (Table 4).

For all seasons combined, prairie chickens generally made most use of Shinnery Oak-Tallgrass subtype 1 (that having the most sand bluestem) and least use of the Mesquite-Shortgrass type, where sand bluestem is absent (Table 5). Use of subtypes 2 and 3 of Shinnery Oak-Tallgrass was intermediate between the two above extremes. During nesting and brooding, subtype 2 was used more than subtype 3, and in fall through spring, reverse was true (Table 5).

In fall-winter, use of types and subtypes was sampled by traversing the study area (48 square miles) along a total of 102 linear miles of census transect, and also by recording all radio-locations of prairie chickens. Both these techniques showed greatest prairie chicken use in Shinnery Oak-Tallgrass subtype 1, second greatest use in subtype 3, next in subtype 2, and least in Mesquite-Shortgrass (Table 6). Radio

Table 1. Percent basal composition of vegetation in the Shinnery Oak-Tallgrass subtypes.

Species	Percent Composition					
	Subtype 1 (30)[a]		Subtype 2 (60)		Subtype 3 (32)	
Grasses	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Sand bluestem	26.8	8.1	8.5	3.6	5.0	3.9
Three-awn	7.7	4.8	16.7	4.8	13.3	6.0
Hairy grama	7.3	4.7	6.7	3.2	3.8	3.4
Little bluestem	5.2	4.1	12.1	4.2	5.8	4.1
Hall's panicum	4.5	3.7	4.6	2.7	4.6	-
Dropseed	3.4	-	3.7	-	5.5	-
Sand lovegrass	1.4	-	3.2	-	0.9	-
Paspalum	0.6	-	1.6	-	1.9	-
False buffalograss	0.6	-	0.7	-	1.1	-
Others	0.3	-	0.3	-	0.3	-
Total Grasses	57.8	9.0	58.1	6.4	42.2	8.7
Shrubs						
Shinnery oak	29.1	8.3	29.1	5.9	43.8	8.8
Yucca	0.7	-	1.3	-	0.7	-
Sand sagebrush	0.5	-	0.3	-	0.9	-
Others	0.5	-	0.2	-	0.4	-
Total Shrubs	30.8	8.4	30.9	6.0	45.8	8.8
Forbs	11.4	5.8	11.0	4.0	12.0	5.7

[a] Number of transects in each subtype.

Table 2. Percent basal composition of grasses and shrubs in the Shinnery Oak-Tallgrass subtypes.

	Percent Composition					
	Subtype 1 (30)[a]		Subtype 2 (60)		Subtype 3 (32)	
Species						
Grasses	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Sand bluestem	30.3	8.4	9.6	3.8	5.7	4.1
Three-awn	8.6	5.1	18.8	5.0	15.1	6.3
Hairy grama	8.1	5.0	7.5	3.4	4.3	3.6
Little bluestem	5.9	4.3	13.6	4.4	6.6	4.4
Hall's panicum	5.1	3.9	5.2	2.9	5.2	3.9
Dropseed	3.8	3.5	4.1	2.6	6.3	4.3
Sand lovegrass	1.6	-	3.6	-	1.0	-
Paspalum	0.7	-	1.8	-	2.2	-
False buffalograss	0.7	-	0.8	-	1.2	-
Others	0.5	-	0.3	-	0.4	-
Total Grasses	65.3	8.7	65.3	6.1	48.0	8.8
Shrubs						
Shinnery oak	32.7	8.6	32.7	6.1	49.8	8.8
Yucca	0.8	-	1.5	-	0.8	-
Sand sagebrush	0.6	-	0.3	-	1.0	-
Others	0.6	-	0.2	-	0.4	-
Total Shrubs	34.7	8.7	34.7	6.1	52.0	8.8

[a] Number of transects in each subtype.

Table 3. Percent basal composition of vegetation in the Mesquite-Shortgrass type.

Species	Percent Composition	
Grasses	Mean	St. Dev.
Blue grama	63.5	16.4
Buffalograss	15.9	20.2
Three-awn	6.0	8.0
Dropseed	2.8	4.0
Sideoats grama	0.6	1.4
Others	0.3	-
Total Grasses	89.1	-
Shrubs		
Broom snakeweed	5.5	7.6
Others	0.6	-
Total Shrubs	6.1	-
Forbs		
Croton	1.4	1.9
Unclassified forbs	3.4	4.0
Others	T[a]	-
Total Forbs	4.8	

[a]Less than 0.5 percent.

Table 4. Percent total ground cover in the Shinnery Oak-Tallgrass and Mesquite-Shortgrass vegetation types.

Types/Subtypes	Plant		Litter		Bare	
Shinnery Oak-Tallgrass	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Subtype 1 (30)[a]	18.8	7.1	42.9	9.0	38.3	8.9
Subtype 2 (60)	11.7	4.1	32.8	6.1	55.5	6.4
Subtype 3 (32)	9.2	2.5	31.7	8.3	59.1	8.7
Mesquite-Shortgrass (30)	26.3	2.1	19.4	11.1	54.1	9.2

[a] Number of transects in each type/subtype.

Table 5. Summary of relative use of Shinnery Oak-Tallgrass subtypes, and Mesquite-Shortgrass, in all seasons.

Season and Technique	Relative Use			
	Shinnery Oak-Tallgrass Subtypes			Mesquite-Shortgrass
	1	2	3	
Fall-Winter				
Census transects	1	3	2	4
Radio-location	1	3	2	4
Spring-Early Summer				
Radio-location (prenesting females)	1	3	2	4
Late Spring-Summer				
Radio-location (nests)	1	2	3	No Nests
Census transects (broods)	1	2	3	No Use
Radio-location (post-nesting females)	2	1	3	4

Table 6 . Relative use of Shinnery Oak-Tallgrass subtypes, and Mesquite-Shortgrass, in fall-winter of 1977-78.

Technique and Unit of Measure	Shinnery Oak-Tallgrass Subtypes			Mesquite-Shortgrass
	1	2	3	
Census Transects No. encounters/mi.[a]	0.74(12)[b]	46 0.43(~~32~~)	32 0.68(~~46~~)	0 (12)
Radio-Location No. encounters/% of area[c]	3.20(12)[d]	44 0.82(~~33~~)	33 2.40(~~44~~)	0.70 (11)

[a] Number of encounters with either birds or their sign per linear mile of transect in the vegetation type or subtype.

[b] Number of linear miles of transect in the vegetation type or subtype.

[c] Number of encounters via radio in the vegetation type or subtype divided by the percent of the study area occupied by the type or subtype.

[d] Percent of the study area occupied by the vegetation type or subtype.

location of prenesting females, mostly in spring, showed the same relative use among vegetation types and subtypes as in fall-winter (Table 7).

The 37 nests (late spring and early summer) all were found in the Shinnery Oak-Tallgrass type, clearly indicating avoidance of Mesquite-Shortgrass by nesting females (Table 8). Nests were most abundant in subtype 1, next in subtype 2, and least in subtype 3. The abundance of broods, as indicated by over 200 miles of census transects (Table 9), varied among types and subtypes in the exact same sequence as abundance of nests. Use of types and subtypes by radio-equipped postnesting females (Table 10) varied from this pattern by indicating greater use of Shinnery Oak-Tallgrass subtype 2 than of subtype 1. However, the use of subtype 2 was only slightly higher than of subtype 1 (preferences indices of 1.36 and 1.29); and use of both subtypes was greater than would be expected had no preference occurred (Table 10).

The patterns of use among vegetation types and subtypes, described above, are explained to the extent possible by the data presented in following sections of this report. In general, prairie chickens in this study were most abundant in areas having considerable sand bluestem. They are attracted to such areas and avoid or make minimal use of more open areas such as Shortgrass-Mesquite. Shinnery Oak-Tallgrass areas provide food and also cover for nesting, brood-rearing, and all daily activities. Where sand bluestem is more abundant (subtype 1), nests are more abundant (Table 8) and nesting success (described later) is greatest.

Table 7. Preference indices and Chi square analysis of relative use of Shinnery Oak-Tallgrass subtypes, and Mesquite-Shortgrass, by radio-equipped prenesting females, 1976 through 1978.

	Shinnery Oak-Tallgrass Subtypes 1	2	3	Mesquite-Shortgrass	Total
Preference Index (Observed/Expected)	1.58	0.91	0.97	0.79	-
Percent of Observations					
Observed	19.05	40.20	32.18	8.57	100.0
Expected	12.04[a]	44.02	33.14	10.80	100.0
Chi Square Data					
$(\text{Obser.}-\text{Exp.})^2/\text{Exp.}$	4.08	0.33	0.03	0.46	4.90[b]

[a] Expected percent of observations corresponds to the percent of the study area occupied by the vegetation type or subtype. For example, if no preference for type or subtype occurred, only 12.04 percent of the observations should have occurred in subtype 1 because that subtype occupies 12.04 percent of the study area.

[b] For Chi square of 4.90 with three degrees of freedom, $P < 0.250$. This indicates the probability of being incorrect in saying that the observed values are different from the expected values.

Table 8. Preference indices and Chi square analysis of relative use of Shinnery Oak-Tallgrass subtypes for nesting, 1976 through 1978.

	Shinnery Oak-Tallgrass Subtypes			
	1	2	3	Total
Preference Index (Observed/Expected)	1.80	1.17	0.50	-
Number of Nests				
Observed	9	21	7	37
Expected	5(13.5)[a]	18 (49.4)	14 (37.1)	37 (100.0)
Chi Square Data $(\text{Obser.-Exp.})^2/\text{Exp.}$	3.20	0.50	3.50	7.20[b]

[a] Expected number of nests is the number corresponding to the percent of the Shinnery Oak-Tallgrass type occupied by the subtype. For example, if no subtype preference occurred, only five nests (13.5% of 37) should have been found in subtype 1 because that subtype made up 13.5 percent of the Shinnery Oak-Tallgrass vegetation type.

[b] For Chi square of 7.20 with two degrees of freedom $P < 0.050$. This indicates the probability of being incorrect in saying that the observed values are different from the expected values.

Table 9. Relative use of Shinnery Oak-Tallgrass subtypes, and Mesquite-Shortgrass, by broods, summers of 1977 and 1978.

	Shinnery Oak-Tallgrass Subtypes			Mesquite-Shortgrass
	1	2	3	
Encounters with Broods or Brood Sign/Mile				
1977	0.08 (12.1)[a]	0.29 (45.4)	0.18 (37.0)	0 (16.2)
1978	0.44 (15.9)	0.07 (40.6)	0.12 (33.8)	0 (11.7)
Combined	0.29 (28.0)	0.18 (86.0)	0.16 (70.8)	0 (27.9)

[a] Number of miles of census transect in the type or subtype.

Table 10. Preference indices and Chi square analysis of relative use of Shinnery Oak-Tallgrass subtypes, and Mesquite-Shortgrass by radio-equipped postnesting females, 1976 through 1978.

	Shinnery Oak-Tallgrass Subtypes			Mesquite-Shortgrass	Total
	1	2	3		
Preference Index (Observed/Expected)	1.29	1.36	0.74	0.16	-
Percent of Observations					
Observed	15.50	59.97	24.36	0.17	100.0
Expected	12.04[a]	44.02	33.14	10.80	100.0
Chi Square Data $(\text{Obser.}-\text{Exp.})^2/\text{Exp.}$	0.99	5.78	2.33	10.46	19.56[b]

[a] Expected percent of observations corresponds to the percent of the study area occupied by the vegetation type of subtype. For example, if no preference for type or subtype occurred, only 12.04 percent of the observations should have occurred in subtype 1 because that subtype occupies 12.04 percent of the study area.

[b] For Chi square of 19.56 with three degrees of freedom, $P < 0.005$. This indicates the probability of being incorrect in saying that the observed values are different from the expected values.

NESTING HABITAT

Summary

Prairie chickens nested only in the Shinnery Oak-Tallgrass vegetation type. Principal plants present within 10 feet of nests in greater abundance than in the overall composition included sand bluestem (where readily available), shinnery oak, and dropseed. Ground cover within 10 feet of nests in each subtype included more litter and less bare ground than in the overall subtype, probably due to dense vegetation around nests. Most nests were placed on north or northeast-facing slopes, or in depressions among sandhills, where they were subjected to less direct sunlight and had some protection from prevailing winds. Plants concealing the nest were taller than nearby plants; where nest concealment was provided by grasses, they usually were not heavily grazed. Where females had ready access to a variety of plants (subtypes 1 and 2), they showed a strong preference for bluestem grasses for cover directly at the nest site. Females nested an average of 2.1 mile from the leks on which they were captured and fitted with radio transmitters, but the portion of this distance which represents movement from the lek where copulation occurred to the nest site is unknown. Therefore, conclusions about how close desirable nesting cover should be to leks require conservative interpretation of known distances moved. It is suggested that maximum distance between nesting cover and leks should be one mile.

Vegetation Around Nests

Female prairie chickens were known to nest only in the Shinnery Oak-Tallgrass vegetation type (Figs. 11, 12), apparently avoiding the Mesquite-Shortgrass type altogether. In each subtype, vegetation within 10 feet of nests generally consisted of the plants most abundant in the subtype, but

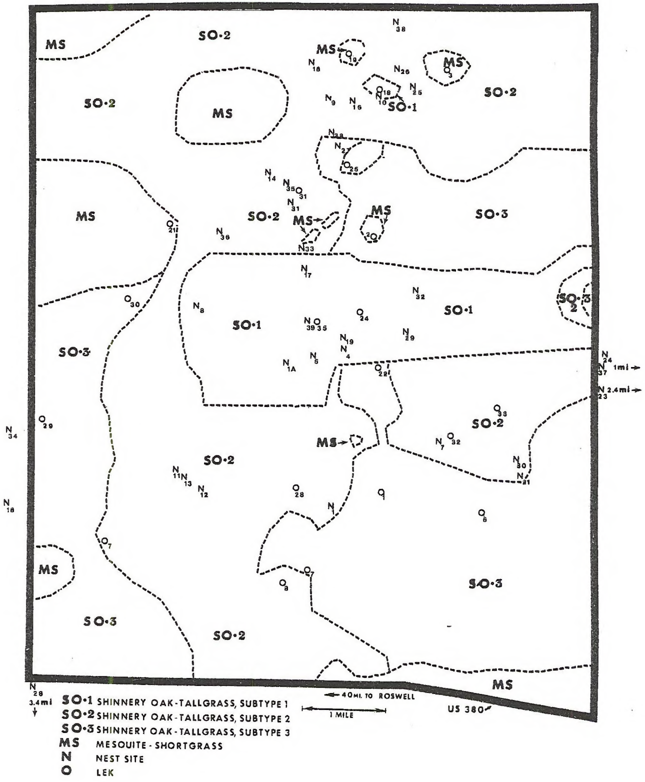

Figure 11. The study area, showing location of nests and leks.

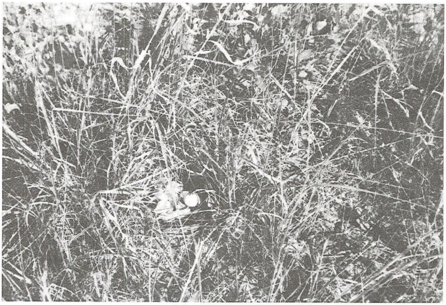

Figure 12. Lesser prairie chicken nest, concealed in cover of sand bluestem.

some selectivity apparently occurred, also. In subtype 1, where sand bluestem and shinnery oak both are abundant, nests tended to be surrounded by more sand bluestem than is present in the overall subtype (Table 11), indicating a selection for that species. In subtypes 2 and 3, where sand bluestem is sparse, nests were surrounded by significantly more shinnery oak than present in the overall subtype (Tables 12, 13). In all three subtypes, the relative abundance of dropseed was greater around nests than in the overall subtype (Tables 11, 12, 13). However, the actual amount present was small, both around nests and in subtype composition. In all subtypes, females nested in areas having less forb growth than the overall subtype (Tables 11, 12, 13), probably because forb cover offers little concealment.

In all three subtypes, significantly more litter and less bare ground occurred around nests than was present in the overall subtype (Table 14). Increased litter probably resulted from more dense vegetation around nests, or from placement of nests in litter-holding areas.

Topography also influenced nest placement. Thirty-four of 37 nests were associated with sandhills. All these 34 were placed either on north-facing or northeast-facing slopes or in small depressions within sandhills. Almost invariably, high dunes were located to the south and west of nest sites; average maximum slopes were highest to the southwest of the 14 nests for which percent slope was measured (Table 15). Protection from prevailing southwest winds and/or from direct sunlight apparently was an important factor influencing nest site selection.

Table 11. Percent basal composition of vegetation in Shinnery Oak-Tallgrass subtype 1 versus that within 10 feet of nests in subtype 1, 1976 through 1978.

Species	Overall Subtype 1 (30)[a]	Nests In Subtype 1 (9)[b]	$P>\|z\|$[c]
Grasses	Mean	Mean	
Sand bluestem	26.8	35.3	<< 0.0005
Little bluestem	5.2	6.1	< 0.5000
Dropseed	3.4	5.0	< 0.1000
Three-awn	7.7	6.0	< 0.4000
Hairy grama	7.3	4.7	< 0.1000
Hall's panicum	4.5	2.5	< 0.1000
Paspalum	0.6	0.4	-
Sand lovegrass	1.4	0.3	-
False buffalograss	0.6	0	-
Others	0.3	0	-
Total Grasses	57.8	60.3	< 0.4000
Shrubs			
Shinnery oak	29.1	29.2	> 0.5000
Yucca	0.7	0.7	-
Sand sagebrush	0.5	0.8	-
Others	0.5	0.6	-
Total Shrubs	30.8	31.3	> 0.5000
Forbs	11.4	8.4	< 0.1000

[a] Number of transects in the subtype.

[b] Number of nests.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 12. Percent basal composition of vegetation in Shinnery Oak-Tallgrass subtype 2 versus that within 10 feet of nests in subtype 2, 1976 through 1978.

Species	Overall Subtype 2 (60)[a]	Nests In Subtype 2 (21)[b]	P>|Z|[c]
Grasses	Mean	Mean	
Sand bluestem	8.5	8.9	> 0.5000
Little bluestem	12.1	5.4	<< 0.0005
Dropseed	3.7	6.1	<< 0.0200
Three-awn	16.7	13.3	< 0.1000
Hairy grama	6.7	4.2	< 0.1000
Hall's panicum	4.6	4.9	> 0.5000
Paspalum	1.6	2.7	-
Sand lovegrass	3.2	1.0	-
False buffalograss	0.7	0	-
Others	0.3	0.2	-
Total Grasses	58.1	46.7	<< 0.0005
Shrubs			
Shinnery oak	29.1	45.1	<< 0.0005
Yucca	1.3	1.0	-
Sand sagebrush	0.3	0.6	-
Others	0.2	0.2	-
Total Shrubs	30.9	46.9	<< 0.0005
Forbs	11.0	6.4	< 0.0500

[a] Number of transects in the subtype.

[b] Number of nests.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 13. Percent basal composition of vegetation in Shinnery Oak-Tallgrass subtype 3 versus that within 10 feet of nests in subtype 3, 1976 through 1978.

Species	Overall Subtype 3 (32)[a]	Nests In Subtype 3 (7)[b]	P>|z|[c]
Grasses	Mean	Mean	
Sand bluestem	5.0	2.0	<< 0.0020
Little bluestem	5.8	0.5	<< 0.0005
Dropseed	5.5	10.7	<< 0.0005
Three-awn	13.3	15.2	< 0.4000
Hairy-grama	3.8	2.1	-
Hall's panicum	4.6	4.6	-
Paspalum	1.9	1.3	-
Sand lovegrass	0.9	0	-
False buffalograss	1.1	0	-
Others	0.3	0	-
Total Grasses	42.2	36.4	<< 0.0100
Shrubs			
Shinnery oak	43.8	50.9	<< 0.0020
Yucca	0.7	1.8	-
Sand sagebrush	0.9	2.7	-
Others	0.4	1.3	-
Total Shrubs	45.8	56.7	<< 0.0005
Forbs	12.0	6.9	<< 0.0010

a Number of transects in the subtype.

b Number of nests.

c Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 14. Percent total ground cover in each subtype of Shinnery Oak-Tallgrass versus that within 10 feet of nests, 1976 through 1978.

Cover	Subtype 1			Subtype 2			Subtype 3		
	Subtype Mean (30)[a]	Mean at Nests (9)[b]	P>|Z|[c]	Subtype Mean (60)[a]	Mean at Nests (21)[b]	P>|Z|[c]	Subtype Mean (32)[a]	Mean at Nests (7)[b]	P>|Z|[c]
Grass	14.5	13.2	<0.4000	8.7	8.0	<0.4000	4.8	6.4	<0.1000
Shrub	3.8	3.2	<0.5000	2.6	2.9	<0.5000	3.7	5.9	<<0.0100
Forb	0.5	1.1	<0.5000	0.4	0.6		0.7	0.3	
Plant	18.8	17.5	<0.5000	11.7	11.5	>0.5000	9.2	12.6	<<0.0100
Litter	42.9	57.6	<<0.0005	32.8	53.3	<<0.0005	31.7	52.9	<<0.0005
Bare	38.3	24.9	<<0.0005	55.5	35.2	<<0.0005	59.1	34.5	<<0.0005

[a] Number of transects.

[b] Number of nests.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 15. Average maximum slopes within 66 yards of 14[a] nests, 1978.

Direction	Average Maximum Slope[b] %
N	1.9
E	2.0
SE	1.9
S	3.8
SW	5.4
W	3.4

[a] Sample includes 12 nests associated with sand hills and two nests found on sandy plains.

[b] Slopes measured using an Abney level from nest site radiating <u>outward</u> in each compass direction.

Vegetation at Nests

Despite the great variety of plant species present in the Shinnery Oak-Tallgrass vegetation type, only a few species were selected to provide cover directly above or beside nests. These were species which were large enough to provide considerable shelter for nests. In subtypes 1 and 2, where females had ready access to all these species, bluestem grasses usually were selected for nest cover (Table 16), indicating a strong preference for these species. Preference for bluestems probably is related to their growth form as exemplified by height, width, and shape of clumps. Other grouse also are known to respond to growth form in selecting nest sites (Christenson 1971, Hillman and Jackson 1973, Wallestad 1975). In subtype 3, where bluestems are scarce, higher use of shrubs (and noticeable use of forbs) occurred.

Females selected taller-than-average plants for nest cover. Mean height of cover at nests was significantly greater than mean height of all vegetation within 10 feet of nests (Table 17). Fifty-four percent (13 of 24) of the grassy nest sites were ungrazed or lightly grazed; 13 percent were moderately grazed, and 33 percent heavily grazed (Appendix IV).

Distance of Nests From Leks

It is highly probable that female lesser prairie chickens (like other western grouse) may make several visits to leks each spring before copulating, but cease such visits immediately after copulating. Therefore, the requirement to capture maximum numbers for attachment of transmitters, in this study, dictated that individual females be captured at the first opportunity -- a bird which copulated before she could be captured was not expected to

Table 16. Principal plant species sheltering nests in each subtype of Shinnery Oak-Tallgrass, 1976-78.

	Subtype 1		Subtype 2		Subtype 3	
Species	No.	Percent	No.	Percent	No.	Percent
Grasses						
Sand bluestem	4	45	2	9	0	0
Little bluestem	3	33	7	33	0	0
Silver bluestem	0	0	1	5	0	0
Three-awn	0	0	5	24	2	29
Total Grasses	7	78	15	71	2	29
Shrubs						
Sand sagebrush	0	0	3	14	2	29
Shinnery oak	1	11	2	10	1	14
Yucca	1	11	0	0	1	14
Total Shrubs	2	22	5	24	4	57
Forbs						
Broom groundsel	0	0	1	5	1	14
Total Forbs	0	0	1	5	1	14

Table 17. Height of vegetation directly above nests versus average height of vegetation within 10 feet of nests, 1976 through 1978.

Subtype	Height of Plant Above Nest (inches)	Height within 10 feet (inches)		$P > \|T\|$[a]
	Mean	Mean	Sample Size	
1	25.1 (9)[b]	12.2	(209)	0.0267
2	16.8 (21)	9.4	(449)	0.0010
3	13.3 (7)	8.2	(159)	0.0200

[a] Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[b] Number of height measurements (one per nest).

[c] Number of height measurements.

present another opportunity for trapping. All birds represented in Table 18, then, are believed to have been captured before copulation, and the distances they moved between capture and nesting (mean = 2.1 mi) consequently represent some pre-copulation movement together with movement from the lek where copulation occurred to the nesting site.

Because of the above conditions, it must be concluded that the mean distance moved from copulation to nesting was less than the 2.1 mile between capture and nesting sites. The large variation in distances moved by individual females (stand. dev. = 2.0, range = 0.3 to 8.7 mi) probably is a result of various individuals being captured at various lengths of time before they copulated; many of those which moved the greater distances could have moved long distances before copulation, and shorter distances from copulation site to nesting site.

Because of the inexact nature of the data (Table 18), conclusions about minimum acceptable distance of desirable nesting cover from leks must be based on a conservative interpretation of these known distances moved. It appears appropriate to suggest that good nesting cover should be present within one mile of leks.

Table 18. Distances moved by females[a] between capture and nesting, springs of 1976 through 1978.

	Distance of Nest From Trap Site
	Miles
Mean	2.1
Confidence Interval (P = 0.05)	0.4
Standard Deviation	2.0
Range	0.3-8.7

[a]Data from all 23 females which were radio-tracked from capture site to nest site.

NESTING SUCCESS

Summary

Success was determined for 36 of the 37 nests found (Table 19). In the following sections, it is shown that percent success generally was greater (1) for the grassier subtypes (subtypes 1 and 2) of Shinnery Oak-Tallgrass, (2) for nests with greater amounts of sand bluestem, three-awn, and total grasses within a radius of 10 feet, and (3) for nests placed directly in cover of sand bluestem. It is presumed that superior cover at and around nests provides for higher success by concealing the nests from predators. Such concealment also may contribute to a lower rate of nest abandonment by providing nesting females with a greater sense of security from predators, weather, and various disturbances.

Habitat management should be aimed at providing an abundance of vegetation typical of that at and around successful nests. Most vegetation available in each subtype for nest concealment was similar to that at and around unsuccessful nests in that subtype, so that only those birds which nested in localized spots of better-than-average cover had a high probability of success.

Table 19. Numbers of successful and unsuccessful nests, and causes of nesting failure, 1976 through 1978.

		Number of Nests	Percent of Total Nests	Percent of Total Unsuccessful
Successful Nests		10	27.0	-
Unsuccessful Nests		26	73.0	100.0
Abandoned		9	-	33.3
Female predation off nest		1	-	3.7
Nest Predation		16	-	63.0
Coyote	3			
Skunk	2			
Unid. Mammal	1			
Snake	6			
Unknown	4			

Influence of Subtype

Percent nesting success (Table 20) was more than three times higher in subtype one (63 percent) than in subtype two (19 percent). In subtype three, success was even lower (14 percent). These differences correspond closely with differences in the percent that sand bluestem contributed to the vegetational composition in the three subtypes, as shown (Table 21) by expressing both nesting success and percent of sand bluestem as multiples of their respective values in subtypes 3, where values were lowest.

It is presumed that the close correspondence between nesting success and proportion of sand bluestem in the subtype composition is due to sand bluestem near nests providing superior nest concealment, as well as a general screening of hen movements near the nest. Nest predators, such as coyotes, may avoid areas of dense sand bluestem in favor of areas where vegetation is sparse and prey is more conspicuous. This relationship between vegetational cover and nesting success is examined further in the following sections.

Influence of Vegetation Around Nests (Successful Versus Unsuccessful Nests)

Vegetation around successful nests in subtypes 1 and 2 included significantly higher percents of sand bluestem and three-awn, and a significantly lower percent of forbs, than did vegetation around unsuccessful nests (Tables 22, 23). Also, the percentage composition of shinnery oak was lower around successful nests in subtype 2. No strong conclusions can be drawn regarding nesting success in subtype 3, due to inadequate sample size. However, it is noteworthy that in this area of extreme scarcity of sand bluestem, the single successful nest was located in an area of very high dropseed composition (Table 24).

Table 20. Nesting success in relation to subtypes of Shinnery Oak-Tallgrass, 1976 through 1978.

Subtype	Nests Started	Successful	
	Number	Number	Percent
1	8	5	63
2	21	4	19
3	7	1	14
Combined	36	10	27

Table 21. Comparison of nesting success with relative amounts of sand bluestem in the three subtypes of Shinnery Oak-Tallgrass, 1976 through 1978.

Subtype	Percent Sand Bluestem In Vegetation	Percent Nesting Success	Percent Sand Bluestem As Multiple of Percent in Subtype 3	Percent Nesting Success As Multiple of Success In Subtype 3
1	26.8	63	5.4	4.5
2	8.5	19	1.7	1.4
3	5.0	14	1.0	1.0

Table 22. Percent basal composition of vegetation within 10 feet of successful nests versus that within 10 feet of unsuccessful nests in Shinnery Oak-Tallgrass subtype 1, 1976 through 1978.

Species	Successful Nests (5)[a]	Unsuccessful Nests (3)	$P>\|Z\|$[b]
Grasses	Mean	Mean	
Sand bluestem	39.5	23.8	<< 0.0005
Little bluestem	6.3	5.8	> 0.5000
Dropseed	3.0	6.7	< 0.0500
Three-awn	7.8	2.9	<< 0.0200
Hairy grama	4.5	6.7	< 0.4000
Hall's panicum	2.5	2.5	-
Paspalum	0.2	0.8	-
Sand lovegrass	0.2	0	-
False buffalograss	0	0.4	-
Total	64.0	49.6	<< 0.0010
Shrubs			
Shinnery Oak	30.3	29.6	> 0.5000
Yucca	0.5	1.3	-
Sand sagebrush	1.5	0	-
Others	0.2	0.4	-
Total	32.5	31.3	> 0.5000
Forbs Total	3.5	19.1	<< 0.0005

[a] Number of nests.

[b] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 23. Percent basal composition of vegetation within 10 feet of successful nests versus that within 10 feet of unsuccessful nests in Shinnery Oak-Tallgrass subtype 2, 1976 through 1978.

Species	Successful Nests (4)[a]	Unsuccessful Nests (17)	$P > \lvert Z \rvert$[b]
Grasses	Mean	Mean	
Sand bluestem	14.1	7.6	<< 0.0010
Little bluestem	5.6	5.3	> 0.5000
Dropseed	7.2	5.8	< 0.4000
Three-awn	16.6	12.6	< 0.0500
Hairy grama	4.4	4.2	> 0.5000
Hall's panicum	3.8	5.1	< 0.4000
Paspalum	1.9	2.9	-
Sand lovegrass	0.6	1.0	-
Total Grasses	0.9	0	-
	55.1	44.5	<< 0.0010
Shrubs			
Shinnery oak	40.9	46.0	< 0.1000
Yucca	0.9	1.0	-
Sand sagebrush	0	0.8	-
Others	0	0.3	-
Total Shrubs	41.8	48.1	< 0.0500
Forbs	3.1	7.4	<< 0.0100

[a] Number of nests.

[b] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 24. Percent basal composition of vegetation within 10 feet of the one successful nest versus that within 10 feet of unsuccessful nests in Shinnery Oak-Tallgrass subtype 3, 1976 through 1978.

Species	Successful Nests (1)[a]	Unsuccessful Nests (6)
Grasses	Mean	Mean
Sand bluestem	0	2.3[b]
Little bluestem	0	0.6
Dropseed	21.3	9.0
Three-awn	2.5	17.3
Hairy grama	0	2.5
Hall's panicum	0	5.4
Paspalum	0	0.8
Total Grasses	23.8	37.9
Shrubs		
Shinnery oak	57.5	49.8
Yucca	6.2	1.0
Sand sagebrush	2.5	2.7
Others	0	1.2
Total Shrubs	66.2	54.7
Forbs	10.0	7.4

[a] Number of nests.

[b] Statistical comparisons of means not feasible with only one successful nest.

Ground cover around successful nests in subtype 1 had significantly more litter and less bare ground than did comparable areas around unsuccessful nests (Table 25). Areas dominated by bunchgrasses, particularly sand bluestem, were observed to accumulate more litter than areas dominated by shrubs or forbs, providing more litter and standing dead stems for nest concealment. Hence, more litter would be expected around successful nests due to higher grass composition. These trends (more litter and less bare ground around successful nests) were not apparent in subtypes 2 and 3, where shrub cover was more abundant and grass cover less abundant.

The height of vegetation around nests also affected nesting success. In subtypes 1 and 3, vegetation was significantly taller around successful nests than around unsuccessful nests (Table 26). Likewise, sand bluestem and dropseed were significantly taller around successful nests in Subtypes 1 and 3; little bluestem was significantly taller around successful nests in subtypes 1 and 2 (Table 27).

Heavier livestock grazing apparently reduced nesting success as it reduced height of key grasses. Livestock utilization of sand bluestem and dropseed was significantly heavier around unsuccessful nests than around successful nests in both subtypes 1 and 3 (Table 28); utilization of little bluestem was heavier around unsuccessful nests in Subtypes 1 and 2.

Influence of Vegetation at Nests

Success was highest for nests having sand bluestem as the principal cover directly at (above and/or beside) the nest (Table 29). Nests associated with all other plant species had lower success (silver bluestem discounted because of small sample size). Similarly, nesting success was

Table 25. Percent total ground cover within 10 feet of successful nests versus that within 10 feet of unsuccessful nests in each subtype of Shinnery Oak-Tallgrass, 1976 through 1978.

Cover	Subtype 1			Subtype 2			Subtype 3	
	Successful (5)[a]	Unsuccessful (3)	P>|Z|[b]	Successful (4)[a]	Unsuccessful (17)	P>|Z|[b]	Successful (1)[a]	Unsuccessful (6)
	Mean	Mean		Mean	Mean		Mean	Mean[c]
Grass	12.3	10.4	<0.5000	10.0	7.5	<0.2000	5.0	6.6
Woody	3.0	3.8	>0.5000	1.5	3.5	<0.0500	15.0	4.4
Forb	0.2	2.9		0.1	0.5		2.5	0
Plant	15.5	17.1	>0.5000	11.6	11.5	>0.5000	22.5	11.0
Litter	67.2	50.0	<<0.0005	51.9	53.6	>0.5000	41.3	54.8
Bare	17.3	32.9	<<0.0005	36.5	34.9	>0.5000	36.2	34.2

a Number of nests.

b Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

c Statistical comparisons of means not feasible with only one successful nest.

Table 26. Height of vegetation within 10 feet of successful nests versus that within 10 feet of unsuccessful nests, 1976 through 1978.

Subtype	Successful Nests	Unsuccessful Nests	P>|T|[a]
	Mean Height (inches)	Mean Height (inches)	
1	13.3 (5)[b]	9.1 (3)	0.0001
2	9.4 (4)	9.4 (17)	0.9955
3	15.4 (1)	7.4 (6)	0.0001
All subtypes	11.9 (10)	8.6 (26)	0.0001

[a]Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[b]Number of nests.

Table 27. Height of sand bluestem, little bluestem and dropseed within 30 feet of successful nests versus that within 30 feet of unsuccessful nests, 1976 through 1978.

Species	Subtype 1			Subtype 2			Subtype 3		
	Successful (5)[a]	Unsuccessful (3)	P > |T|[b]	Successful (4)[a]	Unsuccessful (17)	P > |T|[b]	Successful (1)[a]	Unsuccessful (16)	P > |T|[b]
	Inches	Inches		Inches	Inches		Inches	Inches	
Sand bluestem	37.0(70)[c]	17.2(72)	0.0001	10.2(80)	9.8(368)	0.7510	10.7(4)	4.3(64)	0.3462
Little bluestem	30.1(44)	12.1(65)	0.0001	20.2 (73)	12.6(362)	0.0001	-	5.1(118)	-
Dropseed	18.1(65)	9.6(69)	0.0010	9.4(85)	8.9(373)	0.4700	15.4(24)	4.3(125)	0.0001

[a] Number of nests.

[b] Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[c] Number of individual plants evaluated.

Table 28. Percent grazing utilization of sand bluestem, little bluestem, and dropseed within 30 feet of successful versus that within 30 feet of unsuccessful nests, 1976 through 1978.

	Subtype 1			Subtype 2			Subtype 3		
Species	Successful (5)[a]	Unsuccessful (3)	P>|T|[b]	Successful (4)[a]	Unsuccessful (17)	P>|T|[b]	Successful (1)[a]	Unsuccessful (6)	P>|T|[b]
Sand bluestem	23.2 (70)[c]	60.4 (72)	0.0001	65.9 (80)[c]	67.9 (368)	0.4309	65.4 (4)[c]	82.0 (64)	0.0103
Little bluestem	7.0 (44)	27.4 (65)	0.0001	12.3 (73)	29.8 (362)	0.0001	-	51.5 (118)	-
Dropseed	31.1 (65)	59.0 (69)	0.0001	55.5 (85)	57.7 (373)	0.3392	42.3 (24)	73.1(125)	0.0001

[a] Number of nests.

[b] Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[c] Number of individual plants evaluated.

Table 29. Nesting success in relation to principal cover at the nest, 1976 through 1978.

Nest Placement	Nests Started	Nests Successful	
Species	No.	No.	Percent
Grasses			
Sand bluestem	6	4	67
Little bluestem	9	2	22
Silver bluestem	1	1	100
Three-awn	7	1	14
Total	23	8	34
Shrubs			
Sand sage	5	1	20
Shinnery oak	4	0	0
Yucca	2	1	50
Total	11	2	18
Forbs			
Broom groundsel	2	0	0
Total	2	0	0

highest for all grassy nest sites combined than for non-grassy sites.

Apparently, the growth form of sand bluestem favors nesting success. Sand bluestem clumps often are as much as 10 feet in diameter. The clump is composed of much litter and standing growth which is very loose in nature, so that nests can be placed inside with little effort.

Only two (7.7 percent) of the 26 unsuccessful nests were placed directly in or beside sand bluestem, and they were in low clumps where concealment had been reduced considerably by grazing (Appendix IV).

The height of vegetation concealing successful nests was significantly greater than height of vegetation "concealing" unsuccessful nests in all three subtypes (Table 30). This no doubt was related to livestock grazing intensity of nest clumps, as described above for the two unsuccessful nests which were in low clumps of sand bluestem.

Successful Nests Versus Subtypes (Background for Management)

Although most lesser prairie chickens exercise some selection for concealed nest sites (see "Nesting Habitat"), it has been shown above that successful nests generally are only those having greater amounts of cover, especially sand bluestem. In considering habitat management alternatives, it is helpful to recognize that the specific goal should be to provide vegetation similar to that of successful nests. With this in mind, it is instructive to compare vegetation at and around successful nests with vegetation generally available in the three subtypes of Shinnery Oak-Grassland.

Results of comparing vegetation at and near successful nests with vegetation generally available are very similar to comparisons of successful versus unsuccessful nest vegetation. That is, most of the

Table 30. Height of vegetation directly above successful nests versus that above unsuccessful nests, 1976 through 1978.

Subtype	Successful Nests	Unsuccessful Nests	P>|T|[a]
	Mean Height (inches)	Mean Height (inches)	
1	34.4 (5)[b]	14.4 (3)	0.0218
2	22.0 (4)	15.6 (17)	0.0816
3	19.7 (1)	12.3 (6)	-

[a] Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[b] Number of height measurements.

vegetation available for nest cover was similar to that at and around unsuccessful nests, so that only those prairie chickens which nested in localized spots of better-than-average cover had a high probability of success.

Sand bluestem was signficantly higher and forb growth significantly less in the composition at successful nest sites than in the overall averages in subtypes 1 and 2 (Tables 31, 32). In subtype 2, where sand bluestem was less abundant, dropseed and even shinnery oak also were higher in the vegetational composition at successful nest sites than in the subtype average.

Apparently, the increased shinnery oak composition around successful nests in Subtype 2 aided nesting success. This higher shrub composition may have partially compensated for the lower amount of sand bluestem present at these sites. The very low overall nesting success observed in Subtype 2, however, indicates that the growth form of shrubs in most cases, does not adequately compensate for lower sand bluestem composition in aiding nesting success. The one successful nest in subtype 3 (table 33) provided too few data for strong conclusions, but it is interesting to note that in this subtype of great scarcity of bluestems, adequate cover was provided for the one successful nest by dropseed and shinnery oak. This is not a good situation, however, as evidenced by a general shortage of nests and very low success in subtype 3.

Ground cover around successful nests included significantly more litter and less bare ground than did subtype averages (Table 34). As discussed previously, most grass species accumulate more dead foliage from previous years than do shrubs or forbs, providing more cover for nest concealment.

Table 31. Percent basal composition of vegetation in Shinnery Oak-Tallgrass subtype 1 versus that within 10 feet of successful nests in subtype 1, 1976 through 1978.

Species	Subtype 1(30)[a]	Successful Nests (5)[b]	$P>\|Z\|$[c]
Grasses	Mean	Mean	
Sand bluestem	26.8	39.5	<< 0.0005
Little bluestem	5.2	6.3	< 0.4000
Dropseed	3.4	3.0	> 0.5000
Three-awn	7.7	7.8	> 0.5000
Hairy grama	7.3	4.5	< 0.0500
Hall's panicum	4.5	2.5	-
Paspalum	0.6	0.2	-
Sand lovegrass	1.4	0.2	-
False buffalograss	0.6	0	-
Others	0.3	0	-
Total Grasses	57.8	64.0	< 0.1000
Shrubs			
Shinnery oak	29.1	30.3	> 0.5000
Yucca	0.7	0.5	-
Sand sagebrush	0.5	1.5	-
Others	0.5	0.2	-
Total Shrubs	30.8	32.5	> 0.5000
Forbs	11.4	3.5	<< 0.0005

a Number of transects.

b Number of nests.

c Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 32. Percent basal composition of vegetation in Shinnery Oak-Tallgrass subtype 2 versus that witin 10 feet of successful nests in subtype 2, 1976 through 1978.

Species	Subtype 2 (60)[a]	Successful Nests (4)[b]	$P>\|Z\|$[c]
Grasses	Mean	Mean	
Sand bluestem	8.5	14.1	<< 0.0010
Little bluestem	12.1	5.6	<< 0.0010
Dropseed	3.7	7.2	<< 0.0020
Three-awn	16.7	16.6	> 0.5000
Hairy grama	6.7	4.4	< 0.2000
Hall's panicum	4.6	3.8	< 0.5000
Paspalum	1.6	1.9	-
Sand lovegrass	3.2	0.6	-
False buffalograss	0.7	0	-
Others	0.3	0.9	-
Total Grasses	58.1	55.1	< 0.4000
Shrubs			
Shinnery oak	29.1	40.9	<< 0.0005
Yucca	1.3	0.9	-
Sand sagebrush	0.3	0	-
Others	0.2	0	-
Total Shrubs	30.9	41.8	<< 0.0005
Forbs	11.0	3.1	<< 0.0005

[a] Number of transects.

[b] Number of nests.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 33. Percent basal composition of vegetation in Shinnery Oak-Tallgrass subtype 3 versus that within 10 feet of the one successful nest found in subtype 3, 1976 through 1978.

Species	Subtype 3 (32)[a]	Successful Nest (1)[b]
Grasses	Mean	Mean[c]
Sand bluestem	5.6	0
Little bluestem	5.8	0
Dropseed	5.5	21.3
Three-awn	13.3	2.5
Hairy grama	3.8	0
Hall's panicum	4.6	0
Paspalum	1.9	0
Sand lovegrass	0.9	0
False buffalograss	1.1	0
Others	0.3	0
Total Grasses	42.2	23.8
Shrubs		
Shinnery oak	43.8	57.5
Yucca	0.7	6.3
Sand sagebrush	0.9	2.5
Others	0.4	0
Total Shrubs	45.8	66.3
Forbs	12.0	9.9

[a] Number of transects.

[b] Number of nests.

[c] Statistical comparisons of means not feasible with only one successful nest.

Table 34. Percent total ground cover in each subtype of Shinnery Oak-Tallgrass versus that within 10 feet of successful nests, 1976 through 1978.

Cover	Subtype 1			Subtype 2			Subtype 3	
	Overall Subtype (30)[a]	Successful Nests (5)[b]	P>|Z|[c]	Overall Subtype (60)[a]	Successful Nests (4)	P>|Z|[c]	Overall Subtype (32)[a]	Successful Nest (1)
	Mean	Mean		Mean	Mean		Mean	Mean[d]
Grass	14.5	12.3	<0.4000	8.7	10.0	<0.5000	4.8	5.0
Shrub	3.8	3.0	<0.5000	2.6	1.5	<0.4000	3.7	15.0
Forb	0.5	0.2		0.4	0.1		0.7	2.5
Plant	18.8	15.5	<0.0500	11.7	11.6	>0.5000	9.2	22.5
Litter	42.9	67.2	<<0.0005	32.8	51.9	<<0.0005	31.7	41.3
Bare	38.3	17.3	<<0.0005	55.5	36.5	<<0.0005	59.1	36.2

[a] Number of transects.

[b] Number of nests.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[d] Statistical comparisons of means not feasible with only one successful nest.

Thus, more litter would be expected around successful nests, due to a higher grass composition.

FOOD HABITS

Summary

The diet of birds less than approximately 10 weeks of age was 99-100 percent insects, especially grasshoppers. In summer, adult-size birds also ate mostly (55.3 percent) insects (especially grasshoppers) but they also took considerable amounts of vegetative material (23.3 percent) and acorns (21.4 percent).

The fall diet contained twice the amount of acorns (39.2 percent) as the summer diet, as well as more vegetative material (38.7 percent) and considerably less insect material (18.1 percent). These changes apparently resulted from the declining abundance of insects in fall, in combination with the greater availability of acorns.

In winter, the diet shifted to even greater use of acorns (69.3 percent), with somewhat less use of vegetative material (26.0 percent) and much less use of insects (4.7 percent). This is explained mostly by scarcity of insects at that time.

The most radical change was from winter to spring, when the diet was 78.7 percent vegetative material, a 300 percent increase. A reverse change occurred in acorns (69.3 down to 15.2 percent), and use of insects remained at the same low level as for winter. These changes are explained by changing availability of foods, possibly in combination with changing dietary needs of the birds as they enter breeding condition.

Shinnery oak was the most important item in the year-long diet of adult-size birds. Various combinations of acorns, galls, catkins, and new leaves provided the following percentages of the diet: summer, 22.5 percent; fall, 50.1; winter, 69.3; spring, 49.1.

Summer Foods

The diet of prairie chickens less than approximately four weeks of age ("chicks") was 100 percent insects,[4] especially grasshoppers and treehoppers (Table 35); the two youngest birds collected (apparently under two weeks age) contained 80 percent treehoppers. Juveniles approximately 5-10 weeks of age ate almost entirely grasshoppers (Table 36); use of treehoppers was much less than for chicks.

Adult-sized birds, also, ate more insects (especially grasshoppers) than other foods (Table 37), but took them in much less relative quantity than did chicks and juveniles. The remainder of their summer diet was vegetative material (23.3 percent) and mast and seeds (21.4 percent), notably acorns. Treehoppers, nearly absent from the diet of juveniles, reappeared (10.2 percent) in that of adult-sized birds.

The high use of treehoppers by chicks, especially the smallest ones, may have resulted from their selecting small prey and/or being incapable of feeding on many of the larger grasshoppers. Selection of larger prey by larger birds would explain the shift from treehoppers to greater quantities of grasshoppers by juveniles.

The use of treehoppers by adult-sized birds(10.2 percent) may be surprising, in view of the above. However, these birds ate treehoppers almost exclusively in May, when they ate no grasshoppers. The correct interpretation, apparently, is that adults used treehoppers in May because grasshoppers were not yet readily available, and that chicks ate treehoppers (in June-July, when grasshoppers were abundant) because of their small size.

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[4] All animals, except spiders, listed in Tables 35-40 are insects; scientific names are in Appendix V.

Table 35. Percent composition of the diet of chicks, summers 1976 through 1978.[a]

Food Item	Mean	Standard Deviation
Mast and Seeds		
None		
Vegetative Material		
None		
Animals		
Short-horned grasshoppers	49.5	32.1
Treehoppers	26.1	38.0
Long-horned grasshoppers	12.1	17.2
Ants	4.5	9.6
Mantids	2.8	-
Snout beetles	2.0	-
Robber flies	2.0	-
Darkling beetles	1.0	-
Cockroaches	T[b]	-
Total Animals	100.0	

[a] Contents of crops from 10 birds approximately 1-4 weeks of age, collected in June-July.

[b] Trace (less than 0.1 percent).

Table 36. Percent composition of the diet of young juveniles, summers 1976 through 1978.[a]

Food Item	Mean	Standard Deviation
Mast and Seeds		
Shinnery oak acorns	0.5	2.3
Narrowleaf gromwell seeds	0.1	
Total Mast and Seeds	0.6	2.3
Vegetative Material		
Erect dayflower (leaves, flowers)	0.1	
Total Vegetative Material	0.1	0.4
Animals		
Short-horned grasshoppers	80.4	20.5
Long-horned grasshoppers	7.7	12.6
Mantids	4.4	6.9
Snout beetles	3.1	-
Crickets	1.8	-
Treehoppers	0.6	-
Robber flies	0.4	-
Click beetles	0.3	-
Unidentified insects	0.3	-
Leaf beetles	0.1	-
Silken fungus beetles	0.1	-
Flies	0.1	-
Total Animals	99.3	2.4

[a] Contents of crops from 17 birds, approximately 5-10 weeks of age, collected in July-August.

Table 37. Percent composition of the summer[a] diet of adult-size prairie chickens, 1976 through 1978.[b]

Food Item	Mean	Standard Deviation
Mast and Seeds		
Shinnery oak acorns	21.2	34.4
Unknown seeds	0.2	0.9
Total Mast and Seeds	21.4	34.9
Vegetative Material		
Erect day flower (leaves, flowers)	7.6	22.1
Fame flower (leaves, flowers)	5.2	22.2
Broom snakeweed (leaves)	4.4	13.9
Buckley penstemon (leaves)	2.8	11.2
Insect galls from shinnery oak	1.1	4.0
Broom groundsel (leaves)	0.8	2.2
Unknown flowers	0.6	2.6
Shinnery oak (leaves)	0.2	0.9
Spurge (leaves)	0.2	1.0
Daisy fleabone (leaves, flowers)	0.2	0.8
Composite (buds)	0.2	0.7
Total Vegetative Material	23.3	30.6
Animals		
Short-horned grasshoppers	25.4	36.3
Long-horned grasshoppers	13.7	29.0
Treehoppers	10.2	20.7
Ants	3.1	13.2
Mantids	0.8	3.5
Shield-backed bugs	0.5	1.5
Darkling beetles	0.4	1.3
Spiders	0.4	1.4
Snout beetles	0.2	0.4
Caterpillars	0.2	0.8
Silken fungus beetles	0.2	0.7
Moths	0.1	0.5
Robber flies	0.1	0.5
Total Animals	55.3	39.3

[a] May-August 1977 and 1978, and June-August 1976.

[b] Contents of crops from 18 birds.

Fall Foods

The fall diet was determined, for the most part, from crops collected during October through early December. The sample included only four crops taken December 10 to 31, when food-use appeared transitional in nature. The overall fall diet, determined by averaging results from 1976 and 1977, was high in both mast/seeds (especially acorns) and vegetative material (Table 38). Dietary changes from summer to fall probably were related to declining abundance of insects and the coincident ripening of acorns and seeds. The increased use of vegetative material, largely green, really occurred in only one year, apparently as a substitute for acorns which were relatively scarce.

The use of shinnery oak is especially important. This plant provided acorns, leaves, and galls (which may have been mistaken for acorns) for a total of 50.1 percent of the diet.

Differences between 1976 and 1977 are indicated in Appendix VI. Briefly, use of acorns was much lower (and use of other foods higher) in 1977, when production of acorns was so low that the phenomenon was obvious to all workers in the field. The higher use of insects in fall of 1977 also may have been partly related to higher availability of these animals resulting from temperatures being generally higher than in fall of 1976 (Fig. 9).

Winter Foods

A distinct winter diet (i.e., generally different from diets in both spring and fall) appeared to prevail only in January and February. This short sampling period produced only six crops for study. Nevertheless, some conclusions can be drawn due to the nature of their contents in

Table 38. Percent composition of the fall[a] diet, 1976 and 1977.

Food Items	Mean[b]
Mast and Seeds	
Shinnery oak acorns	39.2
Spurge seeds	2.2
Narrowleaf gromwell seeds	1.8
Spectacle pod seeds	t[c]
Total Mast and Seeds	43.2
Vegetative Material	
Insect galls from shinnery oak	9.5
Broom groundsel (leaves)	6.5
Dwarf dalea (leaves)	6.4
Wildbuckwheat (shoots)	3.0
Narrowleaf gromwell (leaves)	2.0
Downy phlox (leaves)	2.0
Spurge (leaves)	1.9
Composite (flower buds)	1.9
Evening primrose (leaves)	1.8
Shinnery oak (leaves)	1.4
Bitterweed (leaves)	0.9
Broom snakeweed (leaves)	0.6
Wildbuckwheat (leaves)	0.5
Buckley penstemon (leaves)	0.3
Total Vegetative Material	38.7
Animals	
Short-horned grasshoppers	14.7
Crickets	1.6
Caterpillars	0.9
Long-horned grasshoppers	0.3
Ground beetles	0.2
Shield-backed bugs	0.1
Scentless plant bugs	0.1
Walking sticks	0.1
Unidentified beetles	0.1
Treehoppers	t[c]
Spiders	t
Total Animals	18.1

[a]October through December.

[b]Values obtained by averaging mean values from 1976 (crops from 9 birds) and 1977 (crops from 17 birds).

[c]Trace (less than 0.1 percent).

combination with appreciation for typical winter conditions and food supplies.

Winter foods were mostly acorns, with lesser amounts of green vegetation and very small amounts of insects (Table 39). This shift (after fall) to still greater use of acorns is attributed to further decline in availability of insects as temperatures became lower, possible in combination with a greater need for carbohydrates to sustain body temperature. These changes were accompanied by some reduction in use of green vegetation; this may have been caused by either reduced supplies of green material, or greater dependence on acorns.

Spring Foods

A radical change in the diet occurred between February and March. The spring diet was 78.7 percent vegetative (green) material (Table 40), an increase of 300 percent over the winter value. A reverse change occurred in use of acorns (from 69.3 percent down to 15.2 percent), and use of insects remained at the same level as in winter.

The sudden shift from acorns to green material in the diet, results, no doubt, from prairie chickens having adapted their breeding cycle to the change in seasons. In this regard, three events occur somewhat in concert:

(1) Warmer weather in spring probably results in less need for carbohydrates supplied by acorns.

(2) Reversal in the relative abundance of the two major foods occurs as green vegetation appears in greater quantity while the acorn supply continues to decline due to decomposition, covering by sand, and consumption by various animals.

Table 39. Percent composition of the winter[a] diet,[b] 1977 and 1978.

Food Item	Mean	Standard Deviation
Mast and Seeds		
Shinnery oak acorns	69.3	15.7
Total Mast and Seeds	69.3	15.7
Vegetative Material		
Wildbuckwheat (leaves)	8.4	9.6
Wildbuckwheat (shoots)	5.5	11.4
Broom groundsel (leaves)	4.9	8.2
Downy phlox (leaves)	3.5	5.0
Buckley penstemon (leaves)	1.8	2.2
Spurge (leaves)	0.6	
Broom snakeweed (leaves)	0.5	
Bitterweed (leaves)	0.4	
Narrow leaf gromwell (leaves)	0.2	
Rubber rabbitbrush	0.1	
Total Vegetative Material	26.0	15.3
Animals		
Ground beetles	4.7	8.7
Ants	t[c]	
Weevils	t	
Total Animals	4.7	9.0

[a] January-February 1977 and 1978.

[b] Contents of crops from 6 birds.

[c] Trace (less than 0.1 percent).

Table 40. Percent composition of the spring[a] diet,[b] 1976 through 1978.

Food Item	Mean	Standard Deviation
Mast and Seeds		
Shinnery oak acorns	15.2	26.3
Unknown seeds	0.3	1.1
Total Mast and Seeds	15.5	
Vegetative Material		
Shinnery oak (catkins)	31.8	44.6
Wildbuckwheat (leaves)	20.1	30.3
Broom snakeweed (leaves)	6.4	21.1
Composite (flowers)	2.9	
Bitterweed (leaves)	2.7	
Downy phlox (leaves)	2.7	
Shinnery oak (leaves)	2.1	
Buckley penstemon (leaves)	2.0	
Spurge (leaves)	1.9	
Broom groundsel (leaves)	1.5	
Unidentified leaves	0.9	
Ratany (leaves)	0.8	
Unidentified shoots	0.7	
Unidentified flowers	0.7	
Vervain (leaves)	0.7	
Rubber rabbitbrush (leaves)	0.4	
Evening primrose (leaves)	0.35	
Narrowleaf gromwell (leaves)	0.1	
Total Vegetative Material	78.7	35.0
Animals		
Treehoppers	3.7	
Scarab beetles	1.3	
Leaf beetles	0.3	
Snout beetles	0.3	
Unidentified beetles	0.3	
Ants	t[c]	
Total Animals	5.9	17.6

[a] March-May 1976, and March-April 1977 and 1978.

[b] Contents of crops from 21 birds.

[c] Trace (less than 0.1 percent).

(3) Physiological needs of the birds no doubt change as they enter breeding condition, indicated by greater use of leks in late February to early March.

The continued importance of shinnery oak (50.1 percent of the diet in fall; 69.3 in winter) is evident. In spring, this species (acorns, catkins, leaves) made up 49.1 percent of the diet. It is evident that any management plans for lands which support lesser prairie chickens should consider the importance of shinnery oak to this species.

The lack of any great change in quantity of insects eaten, between winter and spring, is attributed (at least in part) to a lack of great change in insect availability. It is interesting, however, that a change occurred in the kinds of insects eaten. More treehoppers were eaten than were any other insects, suggesting that they become available earlier in the year than do other insects.

USE OF LEKS

Summary

Leks ("booming grounds") were found in Mesquite-Shortgrass and in Shinnery Oak-Tallgrass and on bare sand dunes, oil pads (abandoned drilling sites), and roads. The basic requirement for lek sites is visibility of the immediate surroundings. This requirement was met, in various areas, by absence or shortness of vegetation or by topography (open hill tops).

Male prairie chickens visited leks more-or-less daily from mid-February to early June, but the peak of female visitation and of copulation was during the first three weeks of April. Censusing numbers of birds on leks would be most productive during this period of greatest breeding activity.

In fall, male prairie chickens visited leks from September through October, until the first period of winterlike weather. However, no females were seen on leks in fall. Daily use of leks were shorter, and territoriality and aggression weaker, in fall than in spring.

Hawks harassed prairie chickens on leks in both spring and fall. However, only one bird, an adult male, was known to be killed by a hawk (Cooper's hawk) on a lek.

Lek Sites

Leks were found on a variety of sites surrounded by all habitat types and subtypes (Table 41). Specific sites included Mesquite-Shortgrass, Shinnery Oak-Tallgrass, bare sand dunes, oil pads, and even ranch roads. This great variety in sites used indicates clearly that requirements for

Table 41. Site descriptions of known leks in the study area, 1976 through 1978.

Lek Number	Site: Oil Pad	Site: Mesquite Short Grass	Site: Shinnery Oak-Tall Grass	Status: Pre-Existing	Status: New
1	x			x	
2		x		x	
3		x		x	
4[a]			x	x	
5			x	x	
6	x			x	
7	x			x	
8	x			x	
19		x		x	
21		x		x	
22	x			x	
24			x	x	
25		x			x
27	x				x
28	x			x	
29	x				x
30		x			x
31			x		x
32			x		x
33			x		x
35		x		x	

[a] Northeast of main study area.

lek sites are rather broad. The basic requirement appears to be visibility of the immediate surroundings in an area of approximately one-fourth acre or (preferably) larger.

The requirement for visibility was met in several ways in the study area. Apparently, Mesquite-Shortgrass areas were preferred lek sites, as the larger and more well-established leks tended to be in such areas. These leks had low (2-4 inches) grass cover and were placed where mesquite and other shrubs were absent or sparse. In some Mesquite-Shortgrass areas, topography was slightly undulating. Leks in such areas often were afforded additional visibility by being placed on the higher areas available. The "oil pads" used as leks had flat, hard-packed surfaces with no vegetation present which would hamper visibility of the immediate area.

In one area having neither Mesquite-Shortgrass nor oil pads nearby, prairie chickens (as many as 50 in fall) used a large bare sand dune as a lek. In another such area, the lek was on a low hill occupied by a somewhat open stand of shinnery oak; visibility was provided by topography (the hill) in conjunction with the open nature of the oak. There was no indication in this study that lesser prairie chickens might fail to occupy any habitat area because of lack of highly preferred lek sites. They seemed much more likely to accept less-preferred lek sites (dunes, shinnery oak hills, roads) than to move to new areas to find lek sites.

Spring Lek Activity

Male prairie chickens began visiting leks as early as mid-February, and continued visiting them until early June. Prior to the time when females began visiting the leks in appreciable numbers (late March), gobbling

("booming") and other display activities were sporadic and numbers of of males on leks varied considerably. Weather greatly affected lek activity during this early period. Display was more intense and sustained on calm, clear mornings whereas it was sporadic and of low intensity on windy or rainy mornings. Birds even failed to appear on leks on some windy or rainy days in late winter and early spring.

When females began visiting the leks regularly, numbers of males present became relatively stable and all display activities (gobbling, strutting, aggression) were intensified. Males also began visiting leks (and displaying) regularly in late afternoon-to-evening.

The peak of female visitation and copulation was from early April to approximately April 20. Then with decreased female attendance, display behavior became progressively more limited until early June when it ceased. Males were seen, occasionally, on leks for a few more days but did not display. If counts of birds on leks are to be used in a census, then the work should be done during the first three weeks of April each year. This is the period when numbers of birds on leks is greatest and relatively stable.

On their daily visits to leks, the birds appeared before dawn and remained for up to three hours after sunrise if not disturbed. Display activity was greatest for about the first hour after sunrise. Birds flushed from the lek during early morning usually returned within a few minutes. During early and mid-April, when use of leks was at a peak, males often spent the night on leks if undisturbed. The period of lek-use in afternoon and evening was about three hours.

Hawks were the most obvious source of natural disturbance at leks. Buteos and marsh hawks were the most abundant species present, but had

minimal effect on prairie chickens. These hawks, especially marsh hawks, usually were ignored by prairie chickens on leks, and none of the few observed attacks by marsh hawks were successful. The chickens were much more wary of prairie falcons and Cooper's hawks, but these species were scarce. The only prairie chicken known to be killed on a lek by a hawk was an adult male which was killed on lek no. 2 by a Cooper's hawk in March of 1976.

Fall Lek Activity

Use of leks by prairie chickens was observed casually in 1976, and somewhat systematically in 1977. Males were seen on leks from late September through October, although no females were seen. The males usually arrived at leks near sunrise and remained about one hour, and occasionally returned again for a similar period near sunset.

Display activities were shorter and less intense in fall than in spring. Territoriality and aggression were weak, and many birds (possibly juveniles) wandered about the lek displaying sporadically. In contrast with spring, birds flushed from a lek in morning remained away until late afternoon and birds flushed in afternoon remained away until next morning.

In 1977, regular use of leks ceased abruptly on October 31, apparently due to the sudden onset of winterlike weather. On that night, low temperature (below freezing) and high wind (approximately 35 mph) occurred. This weather continued the next day and was accompanied by a heavy cloud cover. In 1978, no birds were found on leks during spot checks on October 28 and 29, indicating that use of leks has ceased; local residents reported

that weather similar to that which had terminated use of leks in 1977 occurred several days previously.

The abrupt end of fall lek activity by lesser prairie chickens coincident with the sudden onset of severe weather also was reported by Copelin (1963) for Oklahoma. He described the end of lek activities as being correlated with the first cold weather accompanied by snow or heavy clouds.

As in spring, hawks harassed birds on leks. However, the effect appeared negligible.

DAILY ACTIVITY SITES (FALL AND WINTER)

Summary

Prairie chickens foraged almost exclusively in the Shinnery Oak-Tallgrass type in fall and winter. Vegetation at foraging sites was dominated by taller grasses but included considerable amounts of shinnery oak. The main difference in fall and winter was the increased incidence of shinnery oak at foraging sites in winter, corresponding with increased use of acorns in the diet.

Vegetation at resting/roosting sites in fall/winter, like that at foraging sites, was dominated by grasses (with individual species varying among subtypes) with important smaller amounts of shinnery oak. This similarity indicated that the birds rested (in daytime) and roosted (at night) near foraging areas. There also was a tendency to seek more grassy sites for resting/roosting than for foraging, apparently due to selection of concealing cover. Fall/winter losses to predation appeared high, and may have been related to some scarcity of taller grasses suitable for resting/roosting cover.

Vegetation at resting/roosting sites in fall/winter also tended to be more grassy than overall subtypes. Coloration of grass cover is more like that of prairie chickens than is color of shrub leaves, and the birds may be attracted to grass cover as a result of their evolution as a climax grassland species.

Foraging Habitat (Fall Versus Winter)

Prairie chickens were found almost exclusively in the Shinnery Oak-Tallgrass type in fall and winter (Table 6). Vegetation at foraging sites in this type was dominated by grasses but included considerable shinnery oak; forbs were scarce and were not sampled. Although the sample was small, it appears that there was more shinnery oak (in subtypes 1 and 2) at foraging sites in winter than in fall (Tables 42, 43, 44). This change suggests increased feeding on acorns in winter, and corresponds with the fall-to-winter increase in the proportion of acorns in crop contents (Tables 38, 39). The lack of such a change in subtype 3 may have been due to the abundance of shinnery in that subtype. That is, the birds apparently found it abundant enough for winter foraging in all areas of the subtype.

Much less plant cover, and more bare ground and litter, was present at foraging sites in winter than in fall (Table 45). This change supports the idea that the birds shifted their use to areas of greater abundance of shinnery oak in winter, as areas which are heavily dominated by shinnery are obviously low in total plant cover. That is, they have an open aspect in winter, in comparison with more grassy areas.

Sand bluestem and dropseed also were present at foraging sites in different quantity in fall than in winter (Tables 42, 43, 44). However, these are not food plants, and the inconsistency (among subtypes) of their fall-to-winter changes suggested that these changes were not directly related to prairie chicken foraging. Where either of these decreased from fall to winter, the decrease probably was an artifact of the increase in shinnery oak. Since percent composition always totals 100 percent, the increase in one species must be offset by a decrease in one or more other species.

Table 42. Percent basal composition of vegetation at foraging sites in Shinnery Oak-Tallgrass subtype 1 in fall and winter, 1977-78.

Species	Fall (7)[a]	Winter (8)	P>|T|[b]	P>|Z|[c]
Grasses	Mean	Mean		
Sand bluestem	14.4	23.2	0.0428	
Little bluestem	7.4	7.9	0.8395	
Dropseed	12.3	7.0	0.0185	
Three-awn	18.7	13.0	0.0690	
Hairy grama	8.6	8.6	0.9774	
Hall's panicum	9.3	6.8	0.6538	
Paspalum	0.3	1.4	0.0709	
Blue grama	0.0	0.0		
Sideoats grama	0.0	0.0		
Sand lovegrass	0.0	0.0		
False buffalograss	0.1	0.0		
Buffalograss	0.0	0.0		
Bristlegrass	0.0	0.0		
Sedge	0.0	0.1		
Total Grasses	71.1	68.0		0.500
Shrubs				
Shinnery oak	21.9	28.9	0.2027	
Sand sage	1.9	0.8	0.4378	
Yucca	2.7	1.8	0.2627	
Prickly pear	0.0	0.0		
Mesquite	2.0	0.6	0.3726	
Snakeweed	0.0	0.0		
Rubber rabbitbrush	0.4	0.0		
Euphorbia	0.0	0.0		
Catclaw sensitive briar	0.0	0.0		
Total Shrubs	28.9	32.0		0.200

[a]Number of foraging sites.

[b]Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[c]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 43. Percent basal composition of vegetation at foraging sites in Shinnery Oak-Tallgrass subtype 2 in fall and winter, 1977-78.

Species	Fall (5)[a]	Winter (19)	P>|T|[b]	P>|Z|[c]
Grasses	Mean	Mean		
Sand bluestem	7.6	4.9	0.1879	
Little bluestem	12.4	11.7	0.8285	
Dropseed	13.4	9.9	0.2063	
Three-awn	21.4	19.8	0.6653	
Hairy grama	8.8	4.2	0.0045	
Hall's panicum	5.8	5.6	0.9455	
Paspalum	2.4	2.7	0.8100	
Blue grama	0.0	0.0		
Sideoats grama	0.0	0.9		
Sand lovegrass	0.0	0.4		
False buffalograss	0.2	0.0		
Buffalograss	0.0	0.2		
Bristlegrass	0.0	0.5		
Sedge	0.2	0.0		
Total Grasses	72.2	60.8		<< 0.001
Shrubs				
Shinnery oak	24.2	35.4	0.0012	
Sand sage	0.2	0.5	0.4839	
Yucca	2.0	2.5	0.6435	
Prickly pear	0.0	0.2		
Mesquite	0.0	0.4		
Snakeweed	1.2	0.1	0.4143	
Rubber rabbitbrush	0.2	0.1	0.5112	
Euphorbia	0.0	0.0		
Catclaw sensitive briar	0.0	0.0		
Total Shrubs	27.8	39.2		<< 0.001

[a]Number of foraging sites.

[b]Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[c]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 44. Percent basal composition of vegetation at foraging sites in Shinnery Oak-Tallgrass subtype 3 in fall and winter, 1977-78.

Species	Fall (10)[a]	Winter (23)	P>|T|[b]	P>|Z|[c]
Grasses	Mean	Mean		
Sand bluestem	1.2	2.9	0.0357	
Little bluestem	6.6	6.3	0.8922	
Dropseed	5.9	8.7	0.1622	
Three-awn	27.2	24.2	0.2450	
Hairy grama	6.4	6.6	0.9488	
Hall's panicum	3.5	3.6	0.9155	
Paspalum	2.4	1.8	0.4093	
Blue grama	0.0	0.0		
Sideoats grama	0.1	0.0		
Sand lovegrass	0.0	0.0		
False buffalograss	0.1	0.1	0.8543	
Buffalograss	0.0	0.1		
Bristlegrass	0.0	0.0		
Sedge	0.0	0.0		
Total Grasses	53.4	54.3		> 0.500
Shrubs				
Shinnery oak	43.1	42.9	0.9587	
Sand sage	0.9	0.6	0.4691	
Yucca	1.6	1.6	0.9417	
Prickly pear	0.5	0.3	0.6739	
Mesquite	0.0	0.3		
Snakeweed	0.0	0.0		
Rubber rabbitbrush	0.2	0.0		
Euphorbia	0.1	0.0		
Catclaw sensitive briar	0.2	0.04	0.4624	
Total Shrubs	46.6	45.7		< 0.500

[a]Number of foraging sites.

[b]Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[c]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 45. Percent total ground cover at fall and winter foraging sites (subtypes combined), 1977-78.

	Percent Composition		P>|T|[c]
	Fall (23)[a]	Winter (51)[b]	
	Mean	Mean	
Litter	37.4	46.0	0.0028
Bare	37.4	44.3	0.0071
Plant	25.2	9.7	-[d]

[a]Number of foraging sites sampled in fall.

[b]Number of foraging sites sampled in winter.

[c]Probability of a Type I error. In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[d]Unavailable due to incomplete computer analysis. However, the difference must be significant because it is a much larger difference than occurred in either bare or litter cover, both of which were highly significant.

Foraging Habitat Versus Subtype

Comparison of grass and shrub composition in the Shinnery Oak-Tallgrass subtypes with grass and shrub data from fall and winter foraging sites in the subtypes might be expected to indicate whether prairie chickens selected foraging areas which were unique. However, certain constraints on such a comparison exist, since data describing the subtypes were collected mostly during the growing season but data describing fall and winter habitat-use were collected during October through February. Grazing might alter composition somewhat after the growing season, and weathering no doubt affects some species more than others. Excluding forbs from the sample was intended to reduce the effects of differential weathering on the data. However, some unmeasurable bias may well exist in the data due to some annual grasses weathering more than perennials (shrubs and perennial grasses). Due to these limitations on the probable accuracy of subtype versus foraging site comparisons, only those comparisons of a general nature are attempted, and only large differences should be accepted as realistic.

Vegetation at fall foraging sites (Tables 42, 43, 44) apparently was more grassy, and less shrubby, than that generally available in each of the three subtypes (Table 2). Since any bias in the data due to weathering should have reduced grass composition, this should be a valid difference. The significance of this selection of relatively grassy areas for foraging is unknown, since the only important fall food plant in the data (shinnery oak) was less abundant at foraging sites than in the overall subtype.

Total grass and shrub composition of vegetation at winter foraging sites (Tables 42, 43, 44) was more like that in the overall subtypes (Table 2) than was that at fall foraging sites. This is entirely logical, considering the shift to areas of more abundant shinnery oak (the main food plant), as shown previously.

Foraging Habitat Versus Resting/Roosting Habitat

Data from daytime resting sites were pooled with those from nighttime roosting sites, as these two kinds of sites (including sign left by birds) resembled each other in fall and winter too closely for consistent separation. Data from resting/roosting sites also were pooled for fall and winter, because the sample was too small for seasonal stratification. Comparison of these data with those from foraging sites (fall and winter combined) show considerable similarily (Tables 46, 47, 48). Both groups of data show dominance of grasses, with individual species varying among subtypes, and important smaller amounts of shinnery oak. This similarity suggests that prairie chickens rested and roosted near their foraging areas, and is in agreement with field observations. There is, also, an indication that the birds sought more grassy sites for resting and roosting than for foraging in at least two of the subtypes (Tables 46, 48). The selection of grassy sites for resting/roosting is expected, considering the need for concealment, and the coloration of prairie chickens.

Abundant plants which grow large enough to provide appreciable cover at resting/roosting sites include sand bluestem, little bluestem, dropseed, three-awn, hairy grama, and shinnery oak. The great variation in amounts of these species present at resting/roosting sites

Table 46. Percent basal composition of vegetation at foraging sites and resting/roosting sites in Shinnery Oak-Tallgrass subtype 1 in fall/winter, 1977-78.

Species	Foraging Sites (15)[a]	Resting/Roosting Sites (8)[b]	$P>\|T\|$[c]	$P>\|Z\|$[d]
Grasses	Mean	Mean		
Sand bluestem	19.1	33.5	0.0593	
Little bluestem	7.7	8.1	0.8040	
Dropseed	9.5	10.6	0.5857	
Three-awn	15.7	6.4	0.0029	
Hairy grama	8.6	8.5	0.9587	
Hall's panicum	7.7	6.3	0.6594	
Paspalum	0.9	0.2	0.0913	
Blue grama	0.0	0.0		
Sideoats grama	0.0	0.0		
Sand lovegrass	0.0	0.0		
False buffalograss	0.1	0.0		
Buffalograss	0.0	0.0		
Bristlegrass	0.0	0.0		
Sedge	0.1	0.0		
Total Grasses	69.4	73.6		< 0.050
Shrubs				
Shinnery oak	25.6	24.9	0.8783	
Sandsage	1.3	0.5	0.4288	
Yucca	2.2	1.0	0.1707	
Prickly pear	0.0	0.0		
Mesquite	1.3	0.0		
Snakeweed	0.0	0.0		
Rubber rabbitbrush	0.2	0.0		
Euphorbia	0.0	0.0		
Catclaw sensitive briar	0.0	0.0		
Total Shrubs	30.6	26.4		< 0.050

[a]Number of foraging sites.

[b]Number of resting/roosting sites.

[c]Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[d]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 47. Percent basal composition of vegetation at foraging sites and resting/roosting sites in Shinnery Oak-Tallgrass subtype 2 in fall/winter, 1977-78.

Species	Foraging Sites (24)[a]	Resting/Roosting Sites (7)[b]	P>|T|[c]	P>|Z|[d]
Grasses	Mean	Mean		
Sand bluestem	5.4	5.1	0.8719	
Little bluestem	11.9	10.9	0.8450	
Drospeed	10.7	8.9	0.4497	
Three-awn	20.1	16.0	0.1773	
Hairy grama	5.1	7.1	0.5649	
Hall's panicum	5.7	12.4	0.0536	
Paspalum	2.7	1.0	0.0132	
Blue grama	0.0	0.0		
Sideoats grama	0.7	0.0		
Sand lovegrass	0.3	1.4	0.4746	
False buffalograss	0.04	0.0		
Buffalograss	0.2	0.0		
Bristle grass	0.4	0.0		
Sedge	0.04	0.0		
Total Grasses	63.2	62.8		>0.50
Shrubs				
Shinnery oak	33.1	34.3	0.8446	
Sandsage	0.4	0.9	0.4443	
Yucca	2.4	2.0	0.6625	
Prickly pear	0.2	0.0		
Mesquite	0.3	0.0		
Snakeweed	0.3	0.0		
Rubber rabbitbrush	0.1	0.0		
Euphorbia	0.0	0.0		
Catclaw sensitive briar	0.0	0.0		
Total Shrubs	36.8	37.2		>0.50

[a]Number of foraging sites.

[b]Number of resting/roosting sites.

[c]Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[d]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 48. Percent basal composition of vegetation at foraging sites and resting/roosting sites in Shinnery Oak-Tallgrass subtype 3 in fall/winter, 1977-78.

Species	Foraging Sites (33)[a]	Resting/Roosting Sites (5)[b]	P>|T|[c]	P>|Z|[d]
Grasses				
Sand bluestem	2.4	1.7	0.4685	
Little bluestem	6.4	4.5	0.6880	
Dropseed	7.8	4.8	0.1747	
Three-awn	25.1	29.3	0.1837	
Hairy grama	6.6	13.7	0.3488	
Hall's panicum	3.6	3.5	0.9526	
Paspalum	2.0	1.0	0.2262	
Blue grama	0.0	0.0		
Sideoats grama	0.03	0.0		
Sand lovegrass	0.0	0.0		
False buffalograss	0.1	0.5	0.4882	
Buffalograss	0.1	0.0		
Bristle grass	0.0	0.0		
Sedge	0.0	0.0		
Total Grasses	54.1	59.0		< 0.050
Shrubs				
Shinnery oak	42.9	39.2	0.6817	
Sandsage	0.6	0.8	0.9502	
Yucca	1.6	1.0	0.3450	
Prickly pear	0.4	0.0		
Mesquite	0.2	0.0		
Snakeweed	0.0	0.0		
Rubber Rabbitbrush	0.1	0.0		
Euphorbia	0.03	0.0		
Catclaw sensitive briar	0.1	0.0		
Total Shrubs	45.9	41.0		< 0.050

[a]Number of foraging sites.

[b]Number of resting/roosting sites.

[c]Probability of a Type I error (from t tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

[d]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

in the three subtypes is, no doubt, only a result of different vegetational composition among the subtypes.

Because, as shown above, foraging sites and resting/roosting sites often were in close proximity, the occurrence of cover plants (named above) generally was similar at the two sites. The "expected" kind of difference (cover plants definitely more abundant at rest/roost sites) occurred in only a few instances -- sand bluestem in subtype 1, and three-awn and hairy grama in subtype 3. The greater abundance of certain cover plants at foraging cites than at rest/roost sites (three-awns in subtypes 1 and 2, and dropseed in subtype 3) may have been either accidental or due to their being associated with food species.

During fall and winter of 1977-78, the known loss of radio telemetry birds to predation was 37.5 percent (3 of 8 birds) in a three-month period. Radio contact was with the remaining five birds was lost, and it is assumed that at least some of these birds also were taken by predators. At that time, the study had been in progress during two previous spring-summer periods and personnel were practiced at attaching radio transmitters to prairie chickens. Further, the transmitters were designed to have minimum weight (13-17 gm) and to not interfere with movements of birds carrying them. Therefore, it is assumed that the transmitters did not increase the birds' susceptibility to predation. All three predator-killed birds were found adjacent to fresh rest-roost sites. The fact that the birds were killed on the sites strongly indicates that they were night-roosting sites. It is

possible that this high rate of predation on rest/roost sites was due to a relative scarcity of taller grasses for use as cover. Two of the three known losses to predation occurred in subtype 3 (the least grassy subtype), and one occurred on a relatively brushy site within subtype 2.

Resting/Roosting Habitat Versus Subtype

Because of small sample size, resting/roosting data from fall and winter were combined, as stated previously. Thus, any comparison with subtype vegetation must be rather general. It has been shown in the two previous sections that (1) fall (especially) and winter foraging habitat tend to be more grassy than overall subtypes, and that (2) habitat used for resting/roosting in fall/winter tends to be a little more grassy than that used for foraging, apparently as a result of selection of grasses for cover. Therefore, it should be clear that resting/roosting habitat in fall/winter generally is more grassy than overall subtypes. Again, the reason probably is due to some selection of grasses for cover when resting/roosting. The brownish hues of dried grass cover, present to some degree even in the growing season, probably blend with prairie chicken plumage better than does the green color of shrub leaves. Further, the birds may be attracted to grasses as a result of their evolution as basically a climax grassland species.

SUMMER FORAGING HABITAT

Summary

Brood foraging sites generally were more shrubby and less grassy than overall vegetation available. Forbs and associated insects apparently are more abundant in shrubby areas, and insects have been shown to provide practically the entire diet of young prairie chickens in summer. Therefore, the greater use of shrubby areas for foraging by broods probably was due to abundance of insects in these areas. In plant composition, summer adult foraging sites resembled brood foraging sites closely. As the summer diet of adults was more than one-half insects, it is assumed that adults, like broods, preferred heavier stands of shrubs for foraging because of greater availability of insects in such areas.

In choosing foraging sites, broods were more selective for concealing plant cover than were adults. In subtypes 2 and 3, where (basal) plant cover is relatively sparse, broods foraged in areas having (1) more plant cover than where adults foraged, and (2) more than the average available in the subtype. In subtype 1, where cover is generally abundant, neither broods nor adults made any special selection for overall plant cover. Height of vegetation also indicated that broods were more selective for concealment than were adults--the broods used cover of relatively consistent height (minimum, 9.6 in.) in all three subtypes, whereas adults tolerated declining cover heights from subtypes 1 through 3.

Foraging Habitat

Prairie chickens foraged almost entirely in the Shinnery Oak-Tallgrass type in summer, so grass and shrub vegetation at foraging sites in this type was compared with that available in the overall subtypes. The forb component was not used in this comparison because broods and post-nesting adults were available for study mostly later in the season than when the subtypes were sampled; any difference in forbs between foraging sites and overall subtypes might have been only due to seasonal changes.

Brood foraging sites generally were more shrubby and less grassy than the overall subtypes (Tables 49, 50, 51); the main shrub involved was shinnery oak. Field observations in this study, as well as vegetation sampling in lesser prairie chicken habitat in Oklahoma by Jones (1963) suggest that forbs are more abundant in shrubby areas than in grassy areas. Jones also found that insects are more abundant in shrub-forb areas, and this study (Tables 35, 36) has shown that insects provide practically the entire food source of young prairie chickens. Therefore the greater use of shrubby areas by broods in this study probably was due to an abundance of insects associated with the forbs present in such areas.

Summer adult foraging sites also were more shrubby than were the overall subtypes (Tables 52, 53, 54), and resembled brood foraging sites closely (Tables 55, 56, 57). Total grass composition was virtually the same at these two kinds of sites in subtypes 2 and 3, and total shrub composition was virtually the same in all three subtypes. Differences in individual species generally were very small and/or

Table 49. Percent basal composition of grasses and shrubs in Shinnery Oak-Tallgrass subtype 1 versus that at brood-foraging sites in subtype 1, 1977 and 1978.

Species	Overall Subtype 1 (30)[a]	Brood Forage Sites (13)[b]	$P>\|Z\|$[c]
Grasses	Mean	Mean	
Sand bluestem	30.3	21.2	<< 0.0005
Little bluestem	5.9	8.1	< 0.1000
Dropseed	3.8	8.2	<< 0.0005
Three-awn	8.6	9.9	< 0.4000
Hairy grama	8.1	5.2	<< 0.0100
Hall's panicum	5.1	5.6	< 0.5000
Paspalum	0.7	3.3	-
Sand lovegrass	1.6	0.2	-
False buffalograss	0.7	0.1	-
Others	0.5	0.2	-
Total Grasses	65.3	62.0	< 0.050
Shrubs			
Shinnery oak	32.7	35.1	< 0.2000
Yucca	0.8	1.5	-
Sand sagebrush	0.6	1.3	-
Others	0.6	0.1	-
Total Shrubs	34.7	38.0	< 0.0500

[a] Number of transects.

[b] Number of foraging sites.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 50. Percent basal composition of grasses and shrubs in Shinnery Oak-Tallgrass subtype 2 and at brood-foraging sites in subtype 2, 1977 and 1978.

Species	Overall Subtype 2(60)[a]	Brood Forage Sites (19)[b]	$P>\|z\|$[c]
Grasses	Mean	Mean	
Sand bluestem	9.6	8.7	< 0.4000
Little bluestem	13.6	8.9	<< 0.0005
Dropseed	4.1	9.2	<< 0.0005
Three-awn	18.8	15.6	<< 0.0250
Hairy grama	7.5	3.5	<< 0.0005
Hall's panicum	5.2	3.9	< 0.4000
Paspalum	1.8	1.6	-
Sand lovegrass	3.6	0.3	-
False buffalograss	0.8	1.0	-
Others	0.3	-	-
Total Grasses	65.3	52.7	<< 0.0005
Shrubs			
Shinnery oak	32.7	42.6	<< 0.0005
Yucca	1.5	2.4	-
Sand sage	0.3	0.9	-
Others	0.2	1.4	-
Total Shrubs	34.7	47.3	<< 0.0005

[a] Number of transects

[b] Number of foraging sites.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 51. Percent basal composition of grasses and shrubs in Shinnery Oak-Tallgrass subtype 3 and at brood-foraging sites in subtype 3, 1977 and 1978.

Species	Overall Subtype 3 (32)[a]	Brood Forage Sites (47)[b]	$P>\|z\|$[c]
Grasses	Mean	Mean	
Sand bluestem	5.7	1.7	<< 0.0005
Little bluestem	6.6	2.4	<< 0.0005
Dropseed	6.3	6.2	> 0.5000
Three-awn	15.1	21.6	<< 0.0005
Hairy grama	4.3	1.3	<< 0.0005
Hall's panicum	5.2	7.1	<< 0.0010
Paspalum	2.2	0.7	-
Sand lovegrass	1.0	0.3	-
False buffalograss	1.2	1.7	-
Others	0.4	0.4	-
Total Grasses	48.0	43.6	<< 0.0200
Shrubs			
Shinnery Oak	49.8	50.9	< 0.5000
Yucca	0.8	2.9	-
Sand sage	1.0	2.5	-
Others	0.4	0.1	-
Total Shrubs	52.0	56.4	<< 0.0200

[a] Number of transects.

[b] Number of foraging sites.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 52 . Percent basal composition of grasses and shrubs in Shinnery Oak-Tallgrass subtype 1 versus that at summer adult foraging sites in subtype 1, 1978.

Species	Overall Subtype 1 (30)[a]	Adult Forage Sites (12)[b]	P>|Z|[c]
Grasses	Mean	Mean	
Sand bluestem	30.3	25.0	<< 0.0010
Little bluestem	5.9	9.9	<< 0.0005
Dropseed	3.8	4.0	> 0.5000
Three-awn	8.6	9.8	< 0.4000
Hairy grama	8.1	7.1	< 0.4000
Hall's panicum	5.1	0.2	<< 0.0005
Paspalum	0.7	2.9	-
Sand lovegrass	1.6	-	-
False buffalograss	0.7	0.4	-
Others	0.5	-	-
Total Grasses	65.3	59.3	<< 0.0010
Shrubs			
Shinnery oak	32.7	36.5	<< 0.0250
Yucca	0.8	1.7	-
Sand sagebrush	0.6	0.7	-
Others	0.6	1.8	-
Total Shrubs	34.7	40.7	<< 0.0010

[a] Number of transects.

[b] Number of foraging sites.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 53. Percent basal composition of grasses and shrubs in Shinnery Oak-Tallgrass subtype 2 versus that at summer adult foraging sites in subtype 2, 1978.

Species	Overall Subtype (60)[a]	Adult Forage Sites (10)[b]	P>|z|[c]
Grasses	Mean	Mean	
Sand bluestem	9.6	6.1	<< 0.0050
Little bluestem	13.6	9.2	<< 0.0010
Dropseed	4.1	8.2	<< 0.0005
Three-awn	18.8	10.4	<< 0.0005
Hairy grama	7.5	5.5	< 0.1000
Hall's panicum	5.2	6.3	< 0.2000
Paspalum	1.8	4.4	-
Sand lovegrass	3.6	-	-
False buffalograss	0.8	0.4	-
Others	0.3	0.6	-
Total Grasses	65.3	51.1	<< 0.0005
Shrubs			
Shinnery oak	32.7	46.4	<< 0.0005
Yucca	1.5	1.6	-
Sand sagebrush	0.3	0.1	-
Others	0.2	0.8	-
Total Shrubs	34.7	48.9	<< 0.0005

[a] Number of transects.

[b] Number of foraging sites.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 54. Percent basal composition of grasses and shrubs in Shinnery Oak-Tallgrass subtype 3 versus that at summer adult foraging sites in subtype 3, 1978.

Species	Overall Subtype (32)[a]	Adult Forage Sites (5)[b]	$P>\|z\|$[c]
Grasses	Mean	Mean	
Sand bluestem	5.7	1.5	<< 0.0010
Little bluestem	6.6	3.5	<< 0.0250
Dropseed	6.3	7.4	< 0.4000
Three-awn	15.1	20.4	<< 0.0100
Hairy grama	4.3	3.1	< 0.4000
Hall's panicum	5.2	3.8	< 0.4000
Paspalum	2.2	1.5	-
Sand lovegrass	1.0	-	-
False buffalograss	1.2	0.5	-
Others	0.4	0.3	-
Total Grasses	48.0	42.0	<< 0.0250
Shrubs			
Shinnery oak	49.8	58.0	<< 0.0050
Yucca	0.8	-	-
Sand sagebrush	1.0	-	-
Others	0.4	-	-
Total Shrubs	52.0	58.0	<< 0.0250

[a] Number of transects.

[b] Number of foraging sites.

[c] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 55. Percent basal composition of grasses and shrubs at brood-foraging sites versus that at summer adult foraging sites in subtype 1 of Shinnery Oak-Tallgrass.

Species	Brood Forage Sites (13)[a]	Adult Forage Sites (12)	$P>\|Z\|$[b]
Grasses	Mean	Mean	
Sand bluestem	21.2	25.0	< 0.0500
Little bluestem	8.1	9.9	> 0.5000
Dropseed	8.2	4.0	<< 0.0010
Three-awn	9.9	9.8	> 0.5000
Hairy grama	5.2	7.1	< 0.1000
Hall's panicum	5.6	0.2	<< 0.0005
Paspalum	3.3	2.9	-
Sand lovegrass	0.2	-	-
False buffalograss	0.1	0.4	-
Others	0.2	-	-
Total Grasses	62.0	59.3	< 0.4000
Shrubs			
Shinnery oak	35.1	36.5	< 0.5000
Yucca	1.5	1.7	-
Sand sagebrush	1.3	0.7	-
Others	0.1	1.8	-
Total Shrubs	38.0	40.7	< 0.4000

[a] Number of foraging sites.

[b] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 56. Percent basal composition of grasses and shrubs at brood-foraging sites versus that at summer adult foraging sites in subtype 2 of Shinnery Oak-Tallgrass.

Species	Brood Forage Sites (19)[a]	Adult Forage Sites (10)	$P>\|Z\|$[a]
Grasses	Mean	Mean	
Sand bluestem	8.7	6.1	< 0.0500
Little bluestem	8.9	9.2	< 0.5000
Dropseed	9.2	8.2	> 0.5000
Three-awn	15.6	10.4	<< 0.0010
Hairy grama	3.5	5.5	< 0.0500
Hall's panicum	3.9	6.3	<< 0.0100
Paspalum	1.6	4.4	<< 0.0010
Sand lovegrass	0.3	-	-
False buffalograss	1.0	0.4	-
Others	-	0.6	-
Total Grasses	52.7	51.1	< 0.5000
Shrubs	42.6	46.4	< 0.1000
Shinnery oak	2.4	1.6	-
Yucca	0.9	0.1	-
Sand sagebrush	1.4	0.8	
Total Shrubs	47.3	48.9	< 0.5000

[a] Number of foraging sites.

[b] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 57. Percent basal composition of grasses and shrubs at brood-foraging sites versus that at summer adult foraging sites in subtype 3 of Shinnery Oak-Tallgrass.

Species	Brood Forage Sites (47)[a]	Adult Forage Sites (5)	$P > \|Z\|$[b]
Grasses	Mean	Mean	
Sand bluestem	1.7	1.5	> 0.5000
Little blue	2.4	3.5	< 0.2000
Dropseed	6.2	7.4	< 0.4000
Three-awn	21.6	20.4	< 0.5000
Hairy grama	1.3	3.1	<< 0.0050
Hall's panicum	7.1	3.8	<< 0.0250
Paspalum	0.7	1.5	-
Sand lovegrass	0.3	-	-
False buffalograss	1.7	0.5	-
Others	0.4	0.3	-
Total Grasses	43.6	42.0	> 0.5000
Shrubs			
Shinnery oak	50.9	58.0	<< 0.0050
Yucca	2.9	-	-
Sand sagebrush	2.5	-	-
Others	0.1	-	-
Total Shrubs	56.4	58.0	> 0.5000

[a] Number of foraging sites.

[b] Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

inconsistent among subtypes or unrelated to foods, so that these differences appeared accidental or ecologically unimportant. It is noteworthy that the summer diet of adults was more than one-half insects (Table 37). It is evident, then, that adults as well as broods preferred the heavier stands of shrubs (dominated by shinnery oak) for foraging because of greater availability of insects in such stands.

Broods foraged in plant cover denser than the mean of that available in subtypes 2 and 3, but not in subtype 1 (Table 58). Overall, available plant cover was relatively sparse in subtypes 2 and 3 (11.7 and 9.2 percent) in comparison with subtype 1 (18.8 percent), so the broods (and accompanying hens) apparently selected for concealment in subtypes 2 and 3. Percentages of litter and bare ground in the table probably are unimportant except that they compensate for differences in plant percentages, to make total cover 100 percent.

Unlike broods, adults in subtypes 2 and 3 foraged where plant cover was no greater than the overall means ot the two subtypes (Table 59). Probably, adults have less need for concealment than do broods, as they are able to fly and are larger than some potential predators. Table 60 further reinforces the idea that broods use heavier plant cover when foraging than adults do: Broods clearly foraged in more plant cover than did adults in subtypes 2 and 3. The reverse was true in subtype 1, but the greater need for cover by broods (than by adults) may have been obscured in that subtype because cover in general (not just that measured as basal composition) was so abundant in that subtype.

Table 58. Percent total ground cover in each subtype of Shinnery Oak-Tallgrass versus that at brood foraging sites, 1976 through 1978.

	Subtype 1			Subtype 2			Subtype 3		
	Subtype Mean (30)[a]	Brood Mean (13)[b]	$P>\lvert Z\rvert$[c]	Subtype Mean (60)	Brood Mean (19)	$P>\lvert Z\rvert$	Subtype Mean (32)	Brood Mean (47)	$P>\lvert Z\rvert$
Percent Ground Cover									
Plant	18.8	8.4	<<0.0005	11.7	14.6	<<0.0020	9.2	14.0	<<0.0005
Litter and Bare	81.2	91.6		88.3	85.4		90.8	86.0	

[a]Number of transects.

[b]Numbers of foraging sites.

[c]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 59. Percent total ground cover in each subtype of Shinnery Oak-Tallgrass versus that at adult foraging sites in summers 1976 through 1978.

	Subtype 1			Subtype 2			Subtype 3		
	Subtype Mean (30)[a]	Adult Mean (12)[b]	P>|Z|	Subtype Mean (60)	Adult Mean (10	P>|Z|	Subtype Mean (32)[c]	Adult Mean (5)	P>|Z|
Percent Ground Cover									
Plant	18.8	12.7	<<0.0005	11.7	10.5	<0.5000	9.2	11.0	<0.5000
Litter and Bare	81.2	87.3		88.3	89.5		90.8	89.0	

[a]Number of transects.

[b]Numbers of foraging sites.

[c]Probability of a Type I error (from z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

Table 60. Percent total ground cover and height of vegetation at brood foraging sites versus that at adult foraging sites in summers 1976 through 1978.

	Subtype 1			Subtype 2			Subtype 3		
	Brood Mean (13)[a]	Adult Mean (121)[b]	$P>\lvert Z\rvert$[c]	Brood Mean (19)	Adult Mean (10)	$P>\lvert Z\rvert$	Brood Mean (47)	Adult Mean (5)	$P>\lvert Z\rvert$
Percent Ground Cover									
Plant	8.4	12.7	<0.0020	14.6	10.5	<0.0100	14.0	11.0	<0.1000
Litter and Bare	91.6	87.3		85.4	89.5		86.0	89.0	
			$P<\lvert T\rvert$[c]			$P<\lvert T\rvert$			$P<\lvert T\rvert$
Overall Plant Height (inches)	9.9	9.5	>0.5000	9.6	8.8	<0.2000	11.0	7.2	<<0.0002

[a]Number of brood foraging sites.

[b]Number of adult foraging sites.

[c]Probability of a Type I error (from t tests and z tests, after Lentner 1975). In this case, the values indicate the probability of being incorrect in saying that the two means are different.

The greater need for concealing vegetation (by broods) while foraging is illustrated further by height data in Table 60. Mean height of brood foraging cover was at least 9.6 inches in all subtypes, whereas mean height of adult foraging cover declined from a high of 9.5 inches in subtype 1 to a low of 6.9 inches in subtype 3, in general conformity with the decline in height of overall vegetation indicated by general field observations.

SUMMARY AND CONCLUSIONS

Summary

1. Vegetation in the study area, and in much of the adjacent region, is characterized by two communities, or types: Shinnery Oak-Tallgrass and Mesquite-Shortgrass. The Shinnery Oak-Tallgrass includes three recognizable subtypes which (except for some areas of site differences) appear to represent climax vegetation (subtype 1) and two stages (subtypes 2, 3) in the deterioration of this vegetation. This deterioration generally has resulted from grazing, as indicated by fenceline contrasts and distance of some areas of subtype 1 from stock water in the center of the study area.

The principal indicator species in recognition of the three subtypes of Shinnery Oak-Tallgrass is sand bluestem. This species is prominent (and is the most conspicuous species) in subtype 1, and is progressively less abundant in subtypes 2 and 3.

2. In gėneral, prairie chickens were most abundant in Shinnery Oak-Tallgrass subtype 1, of considerable lower abundance in subtypes 2 and 3 (denser in subtype 2 than in subtype 3 in nesting/brooding season), and usually absent from Mesquite-Shortgrass.

3. Nesting prairie chickens were most abundant in Shinnery Oak-Tallgrass subtype 1, where relatively large amounts of sand bluestem, dropseed, and shinnery oak typically provided cover within 10 feet of nests. Cover directly at (or above) nests was taller than the average of all plants within 10 feet of nests, and usually was ungrazed residual growth from previous years. Most females nested within two miles of the lek on which they were captured.

4. Cover at successful (hatched) nests was quite different from that at unsuccessful nests. Probability of success generally was greater for nests which:

(a) Were located in the grassier subtypes (1 and 2) of Shinnery Oak-Tallgrass, especially subtype 1; differences in nesting success, among subtypes, corresponded closely with differences in abundance of sand bluestem.

(b) Had greater amounts of sand bluestem, three-awn, and total grasses within 10 feet.

(c) Were placed directly in cover of sand bluestem.

5. Insects provided the main summer food, composing 55 percent of the diet of adult-size birds, and 99-100 percent of the diet of chicks and young juveniles. In other seasons, the diet was dominated by various proportions of acorns, galls, catkins, and new leaves of shinnery oak. The percent that this species contributed to the yearlong diet was: summer (adult-size birds), 22.5 percent; fall, 50.1; winter, 69.3; spring, 49.1.

6. A variety of sites were used as leks ("booming grounds") by prairie chickens. Although they prefer very open areas such as Mesquite-Shortgrass for lek sites, the basic requirement is for visibility of their surroundings. This requirement was met in various parts of the study area by absence or shortness of vegetation and/or by topography (low hilltops).

7. In fall and winter, prairie chickens foraged in areas dominated by taller grasses but including considerable amounts of shinnery oak. The main change from fall to winter was the tendency to move to areas more heavily vegetated with shinnery in winter, when the birds also

increased use of shinnery acorns in the diet from 50.1 percent (fall) to 69.3 percent (winter).

8. In fall and winter, prairie chickens rested (in midday) and roosted (at night) in places which tended to be more grassy than both foraging sites and the vegetation generally available. Apparently, this was due to selection of grass cover for concealment. Fall/winter losses to predation seemed high, and may have been associated with some scarcity of quality tallgrass cover for resting/roosting in subtypes 2 and 3. Of the three known losses, two were at resting/roosting sites in subtype 3, and one was at a resting/roosting site in a relatively shrubby area of subtype 2.

9. Prairie chickens foraged in areas of high shrub density in summer, apparently because their main food source (insects) was more abundant in shrubby areas than in more grassy areas. In choosing foraging areas, broods were more selective for concealing plant cover then were adults, foraging in areas of greater plant cover and greater plant height.

Conclusions

1. The findings on relative abundance of prairie chickens and their nests, and on nesting success, indicate clearly that subtype 1 of Shinnery Oak-Tallgrass is the key element in the habitat of lesser prairie chickens in the area studied.

2. The outstanding importance of subtype 1 is due to its containing large proportions of both sand bluestem (averages 26.8 percent of the vegetation) and shinnery oak (averages 29.1 percent). Sand bluestem provides superior concealing cover during the entire year, and is especially critical to nesting success. Shrubby vegetation provides the

staple food (shinnery oak) for fall through spring, and provides habitat for insects which are the staple food in summer.

3. Subtypes 2 and 3 of Shinnery Oak-Tallgrass are inferior habitat for lesser prairie chickens. Although they have abundant shinnery oak, they lack the superior cover of sand bluestem. Subtype 2 is not quite as poor as subtype 3 but still is greatly inferior to subtype 1, as indicated especially by much lower nesting success.

RECOMMENDATIONS

Habitat Goals

1. One critical need in management of habitat for lesser prairie chickens in the East Chaves Planning Unit is to maintain the existing, relatively small area of subtype 1 of Shinnery Oak-Tallgrass.

2. Another critical need is to improve subtypes 2 and 3 so that they become virtually subtype 1 at least in terms of sand bluestem composition. This also will provide much additional annual forage for livestock.

It might seem that a sensible compromise, or middle-of-the-road approach, would be to simply elevate subtype 3 areas to subtype 2 condition. However, probably the most critical finding of this study concerns nesting success -- subtype 1 (with its abundant sand bluestem) provides 300 percent greater nesting success than does subtype 2 (where little bluestem is more abundant); subtype 2 provides only one third greater success than does subtype 3. Therefore, subtype 2 is not a sound ecological goal. A corollary reason for setting subtype 1 as the goal for habitat improvement is the <u>extreme</u> shortage of subtype 1 in this region (about 7 sq. mi. remain). Therefore, <u>the principal recommendation</u> of this study is to restore large areas of subtypes 2 and 3 to subtype 1.

3. Existing variation in range sites and in topography largely eliminates the need for concern about spatial arrangement of necessary habitat components. In existing subtype 1 areas, this variation provides adequate (perhaps near ideal) interspersion of sand bluestem-dominated areas with shinnery-dominated areas, so that desirable grass

cover and desirable foraging habitat rarely are far apart. Further, the blending of sand bluestem and shinnery oak that occurs over much of this subtype insures that both cover and food are present nearly everywhere. Improvement of vegetation in subtype 2 and 3 areas would result in similar situation in those areas.

4. Although the requirements for suitable lek sites seem rather broad (visibility of immediate surroundings), a definite preference for areas of low vegetation (e.g., shortgrasses) or bare ground (e.g., oil pads) does exist. Therefore, it would be desirable to insure that potential preferred lek sites are present throughout the areas. If these are not more than two miles apart, all nests could be placed within about one mile of at least one lek.

5. Although the precise importance of drinking water to lesser prairie chickens is unknown, and was not an object of study in this project, some comment seems appropriate. There can be no doubt that prairie chickens originally existed without benefit of widespread permanent drinking water. No doubt insects and succulent vegetation generally provided sufficient water for survival and reproduction.

Shrinkage of lesser prairie chicken populations is known to have occurred during the drouths of the 1930's and 1950's (Hamerstrom and Hamerstrom 1961, New Mex. Dept. Game and Fish 1967). However, the degree to which this shrinkage could have been alleviated, if it could have been alleviated at all, by drinking water is unknown. Indeed, Frary (1957) found only what he considered to be limited use of prairie chicken water developments in eastern New Mexico in the early 1950's. It should be noted, however, that his observations were somewhat general and that

he was not able to closely evaluate effects of water developments.

It does seem that under recent and current conditions of grassland deterioration, drouth-effects would be greater than before the introduction of intensive grazing. Soils of the region probably have less water-holding capacity as a result of long-term grazing having reduced overall plant and litter cover. Drouths, therefore, can be expected to reduce the supplies of insects and succulent vegetation (sources of water) more than they did prior to the advent of widespread grazing.

One result of temporary drouth was observed during the study. Rainfall was relatively scant during the first three and one-half months of 1976 (Fig. 10), and prairie chickens were commonly seen at stock water tubs in our study area and in the Texas Tech study area, about 80 miles to the northeast. It should be noted that this was during the time of year when egg production would increase bodily water needs. Springs of 1977 and 1978 were wetter, and prairie chickens were not observed at water troughs. Crawford and Bolen (1973) made similar observations at the Texas Tech study area in Yoakum County, Texas in 1972, and concluded that man-made water sources may enhance survival of lesser prairie chickens during periods of spring drouth.

Considering the circumstantial evidence for the importance of drinking water during drouths, development of watering devices for prairie chickens should be considered. If the evidence does not seem strong enough to warrant large-scale development, then trial developments could be made in a limited area. Such a test might easily settle the question during the next major drought, and the present study area is not

too large for such a trial. It would be necessary, of course, to monitor changes in prairie chicken numbers in the trial area in comparison with areas having few or no water developments.

Spacing of water developments is another problem. It would be entirely too costly to attempt to place water sources densely enough to accommodate young broods, because of their low mobility. Adult-size birds readily fly several hundred yards in a single flight, and it would seem (tentatively) that water sources might be placed one mile apart. If this is too costly, even including use of existing stock waters, another approach would be to install clusters of several waterers in each of several areas of the better habitat to insure pockets of survival/reproduction, and leave most areas undeveloped except to insure that stock waterers are usable by prairie chickens.

Methods of Attaining Habitat Goals

1. Maintenance of Existing Subtype 1. The way to maintain existing areas of subtype 1 is to maintain the conditions which have perpetuated this vegetation until the present. The fact that grazing intensity is lighter where subtype 1 now exists is evident from the fenceline contrast along the southern boundary of this subtype (Fig. 11) and also from the lack of livestock water (and relative scarcity of cattle) in the western part of this subtype (Fig. 4). Periodic survey of vegetation composition in subtype 1, along with close monitoring of livestock to insure against increased grazing intensity, will aid in perpetuating the present extent of subtype 1. This effort will be aided further if no additional livestock water developments are permitted in either of the two pastures containing subtype 1 vegetation.

2. Improvement of Subtypes 2 and 3. The evidence for lighter grazing having allowed the survival of existing areas of subtype 1 also indicates clearly that prolonged heavy grazing has reduced other areas to their present status as subtypes 2 and 3. If grazing pressure is not somehow reduced quickly, deterioration of grasslands may proceed at an accelerated speed. This is because a constant number of animal units on an already declining supply of forage can cause the quantity of these grasses to decline faster as time passes.

The most direct way to bring about recovery of sand bluestem in subtype 2 of the Shinnery Oak-Tallgrass community probably is by reducing numbers of animal units in the pastures in question. Range conservationists and/or range managers are the appropriate persons to decide what amount of reduction would be required to effect

recovery of the grassland. An instance of recovery of sand bluestem in subtype 2, in response to curtailed grazing, occurred during this study, in the pasture containing lek 28 (Fig 4). Vegetation in the eastern edge of this pasture was sampled early in the study, and it was subtype 2. No cattle were seen in the pasture during the last year and one-half if the study, and the extreme eastern edge changed (visually at least) to a semblance if subtype 1 in two growing seasons (1977 and 1978).

A pasture-rotation system of grazing probably would effect the desired restoration of grasses in subtype 2 while requiring little or no reduction in livestock numbers. However, the added costs of fencing, water developments, and seasonal relocation of livestock would be high, perhaps prohibitive. Some rotation of grazing could be achieved by seasonal movement of salt and supplemental feeding points, and seasonal opening and closing of stock water sources. However, the success of such manipulations in causing the appropriate seasonal movement of livestock-use is uncertain.

Improvement of subtype 3 would be more difficult, and probably would require some reduction of shinnery oak, in addition to reduction of grazing pressure. Control of shinnery must be only partial, since prairie chickens depend on it for foraging habitat and for their principal food. The method most compatible with prairie chicken needs would be to attempt only a reduction in <u>density</u> of shinnery oak so that some would still be present nearly everywhere, as it now is in subtype 1. Any eradication or near-eradication should be done only in small areas (e.g., individual pastures) in an irregular pattern, leaving some areas untreated until taller grasses (especially sand bluestem) recover in treated areas. Any

reduction in shinnery oak should be accompanied by reduced grazing, to encourage recovery of these grasses. Otherwise, the work can result in maximum damage to prairie chicken habitat.

3. Construction of Livestock Exclosures. The exclusion of grazing from portions of the area (especially in subtype 2) where sand bluestem is scarce and heavily grazed could enhance prairie chicken habitat by providing patches of superior cover relatively quickly, while the bulk of the area is allowed to recover more slowly under continued (but reduced) grazing. Any exclosures must be developed on sites where soil and topography are such that recovery sand bluestem cover can be expected in a reasonable time period. Such sites can be identified by personnel with knowledge of range sites and their potential vegetation.

It should be noted that exclosures probably could not serve as viable substitutes for large-scale restoration of the range as a whole. Although the idea may be ecologically sound, the amount of fencing required to scatter sizeable exclosures throughout the planning unit would be too expensive for implementation.

It should also be noted that this study was not designed to produce information which would relate directly to minimum size or spacing of exclosures. Therefore, conclusions in this regard must be general, and based on experience and general observation. Tentatively, it appears that exclosures of 80 acres might be large enough to be found by enough prairie chickens to be worthwhile. The Mathers Natural Area is an exclosure of approximately 80 acres which is known to be utilized as nesting haibtat. The assumption that 80 acres is large enough is somewhat tenuous, however, because the 80-acre Mathers Area is not isolated -- its use may be partly due to its being contiguous

with a large area of subtype 1. It seems prudent to suggest that exclosures really should be larger, perhaps at least 160 acres.

Each large exclosure (of, say, 160 acres) would greatly improve the usefulness of the area within the exclosure and also the surrounding brushy habitat: The exclosure itself would provide greatly improved nesting cover and fall/winter resting/roosting cover; shrubs already present in the exclosure would provide suitable foraging habitat and food for the forseeable future, and should (through improved nesting cover) result in additional birds to utilize brushy foraging habitat surrounding the exclosure.

4. Development of Lek Sites. The construction of potential lek sites would not be a difficult feat. Such construction could be accomplished readily by clearing vegetation from small areas, levelling them, and installing hard surfaces of caliche similar to those used on oil pads (drilling sites). Lek number 22 could serve as a model for such developments. It is important to recognize that construction of a suitable site would not insure its use by prairie chickens. The birds are influenced, in their selection of lek sites, by behavior which is not entirely predictable. For example, some males were known to establish leks on sites (dominated by shrubs) which appeared much less desirable than open areas of shortgrass which were located nearby.

5. Development of Drinking Water. Any such developments should be constructed specifically for prairie chickens and perhaps for incidental use by other small wildlife species. Such devices can be constructed so that they utilize rainwater, and therefore do not require wells or water lines, although some can be developed in conjunction

with existing livestock water by use of water lines. Details on construction of rain-collecting devices are readily available in the literature, and devices which might be used as models already are present in the vicinity.

The suggestion for consideration of water developments specifically excludes development for livestock. Since a considerable part of existing subtype 1 appears to owe its existence to lack of grazing resulting from lack of water for livestock, it is clear that addition of stock water would encourage overgrazing by concentrating livestock. This would be detrimental to prairie chicken habitat.

Other Recommendations

1. Maintain Natural Vegetation. Any large-scale diversion of Shinnery Oak-Tallgrass, especially subtype 1, into other uses (e.g., cultivation, large oil fields) would cause further deterioration of prairie chicken habitat and eventually would endanger the species' existence in New Mexico. This sequence of events already has occurred in Kansas (Waddell and Hanzlick 1978) and in parts of Oklahoma (Hamerstrom and Hamerstrom 1961) and Texas (Crawford 1976). Establishment of inviolate sanctuaries, wilderness areas, or other natural or scientific areas would mitigate against such possible developments.

2. Minimize Physical Disturbance. Physical disturbance of Shinnery Oak-Tallgrass, especially during March-June when courtship and reproduction are in progress, should be kept to an absolute minimum. Construction of new facilities, such as fences, and oil exploration work should be prohibited during these months, with nesting habitat particularly in mind. Use of off-road recreational

vehicles poses an even greater threat to nesting females; this activity should be prohibited during May and June. Furthermore, one or two leks should be designated as observation sites for spectators, to protect other Shinnery Oak-Tallgrass areas and leks from indiscriminate disturbance.

3. Monitor Trends in Prairie Chicken Numbers. Changes in abundance of prairie chickens must be monitored continually in order to know whether habitat protection and improvement results in a secure (stable or increasing) population. This can be accomplished by surveying leks twice yearly, once in spring and once in fall.

The most accurate survey would be a count of all leks during the first three weeks (or less) of April and during mid-to-late October. Numbers of leks and numbers of birds on leks are most stable during these two periods. Once the specific technique is developed, it should be kept consistent through the years.

There appear to be upper limits on numbers of birds that will occupy one lek, and some leks apparently are alternately occupied and abandoned as abundance fluctuates. Therefore, it is quite important to find all active leks during each survey, in addition to censusing prairie chickens on the leks.

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Appendix I. List of other literature and individuals knowledgeable about lesser prairie chickens and/or techniques applicable to this study (update to lists in progress report for 1 October 1975 through 31 January 1977).

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Appendix II. Common and scientific names of plants mentioned in this report, after Correll and Johnston (1970).

Common Name	Scientific Name
Bitterweed	*Hymenoxys* spp.
Blue grama	*Bouteloua gracilis*
Bristlegrass	*Setaria macrostachya*
Broom groundsel	*Senecio spartioides*
Broom snakeweed	*Xanthocephalum sarothrae*
Buckley penstemon	*Penstemon buckelyi*
Buffalograss	*Buchloe dactyloides*
Catclaw sensitive briar	*Acacia greggii*
Croton	*Croton* spp.
Daisy fleabane	*Erigeron* sp.
Dropseed	*Sporobolus* spp.
Dwarf dalea	*Dalea nana*
Erect dayflower	*Commelina erecta*
Evening primrose	*Oenothera* sp.
False buffalograss	*Munroa squarrosa*
Fameflower	*Talinum parviflorum*
Hairy grama	*Bouteloua hirsuta*
Hall's panicum	*Panicum hallii*
Little bluestem	*Schizachyrium scoparium*
Mesquite	*Prosopis glandulosa*
Narrowleaf gromwell	*Lithospermum incisum*
Paspalum	*Paspalum ciliatifolium*
Phlox	*Phlox* sp.
Prickly pear	*Opuntia* spp.
Ratany	*Krameria* spp.
Rubber rabbitbrush	*Chrysothamnus nauseosus*
Sand bluestem	*Andropogon hallii*
Sand dropseed	*Sporobolus cryptandrus*
Sand lovegrass	*Erogrostis trichodes*
Sand sagebrush	*Artemisia filifolia*
Sedge	Cyperaceae
Shinnery oak	*Quercus havardii*
Sideoats grama	*Bouteloua curtipendula*
Silver bluestem	*Bothriochloa saccharoides*
Snakeweed	*Xanthocephalum* spp.
Spectacle pod	*Dithyraea wislizeni*
Spurge (Euphorbia)	*Euphorbia* spp.
Three-awn	*Aristida* spp.
Vervain	*Verbena* spp.
Wildbuckwheat	*Eriogonum annuum*
Yucca	*Yucca* sp.

Appendix III. Common and scientific names of vertebrates mentioned in this report, after American Ornithologists' Union (1973a, 1973b, 1976), Burt and Grossenheider (1964), and Stebbins (1966).

Common Name	Scientific Name
Balck-tailed jackrabbit	*Lepus californicus*
Black-tailed prairie dog	*Cynomys ludovicianus*
Burrowing owl	*Athene cunicularia*
Buteo hawk	*Buteo* spp.
Common nighthawk	*Chordeiles minor*
Cooper's hawk	*Accipiter cooperi*
Coyote	*Canis latrans*
Diamondback rattlesnake	*Crotalus atrox*
Lesser prairie chicken	*Tympanuchus pallidicinctus*
Loggerheaded shrike	*Lanius ludovicianus*
Marsh hawk	*Circus cyaneus*
Massasauga	*Sistrurus catenatus*
Meadowlark	*Sturnella magna* and *S. neglecta*
Mourning dove	*Zenaida macroura*
Prairie falcon	*Falco mexicanus*
Prairie rattlesnake	*Crotalus viridis*
Pronghorn antelope	*Antilocapra americana*
Roadrunner	*Geococcyx californianus*
Scaled quail	*Callipepla squamata*
Sparrow hawk	*Falco sparverius*
Spotted ground squirrel	*Spermophilus spilosoma*
Striped skunk	*Mephitis mephitis*
Swainson's hawk	*Buteo swainsoni*
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*
Turkey vulture	*Cathartes aura*
Whiptail lizards	*Cnemidophorus* spp.

Appendix IV. Success, age of cover at nest, subtype of Shinnery Oak-Tallgrass, and placement of all 37 nests located, 1976 through 1978.

Number	Success	Age of Cover[a]	Subtype	Nest Placement
1976				
1	Hatched	Old	2	In lightly grazed clump of three-awn[b].
1A	Hatched	Old	1	Beside lightly grazed yucca[b] and sand bluestem clump.
4	Hatched	Old	1	Beside ungrazed clump of little bluestem[b].
5	Hatched	Old	1	In ungrazed clump of sand bluestem[b].
7	Abandoned	Old	2	Beside lightly grazed clump of little bluestem[b].
8	Unknown	Old	1	Between lightly grazed clumps of little bluestem[b] and sand bluestem.
1977				
9	Predator Loss	Old	2	Beside lightly grazed clump of three-awn[b].
10	Predator Loss	Old	2	Beside lightly grazed clump of little bluestem[b].
11	Predator Loss	Current	2	In ungrazed sand sagebrush[b] plant.
12	Predator Loss	Current	2	Beside lightly grazed broom groundsel[b] plant.
13	Abandoned	Current	2	Beside ungrazed sand sagebrush[b] plant.
14	Predator Loss	Old	2	In heavily grazed clump of sand bluestem[b].
15	Hatched	Old	2	In heavily grazed clump of sand bluestem[b].
16	Hatched	Mostly current; some old	3	Between ungrazed sand sagebrush and yucca plants[b].

Appendix IV., Continued

Number	Success	Age of Cover[a]	Subtype	Nest Placement
1977				
17	Predator loss	Old	1	In heavily grazed clump of sand bluestem[b].
18	Hatched	Mostly old; some current	2	Between lightly grazed clumps of silver bluestem[b] and dropseed, and shinnery oak.
19	Hatched	Old	1	In ungrazed clump of sand bluestem[b].
20	Abandoned	Mostly current; some old	3	Beside heavily grazed three-awn[b] and shinnery oak plants.
1978				
21	Abandoned	Old	2	In lightly grazed clump of little bluestem[b].
22	Predator loss	Old	2	Between heavily grazed clumps of three-awn[b] and dropseed, and shinnery oak.
23	Predator loss	Old	3	Between heavily grazed plants of broom groundsel[b], shinnery oak, and three-awn.
24	Abandoned	Old	2	Beside lightly grazed clump of little bluestem[b].
25	Predator loss	Old	2	Beside moderately grazed clump of little bluestem[b].
26	Predator loss	Old	2	Between moderately grazed clumps of little bluestem[b] and three-awn.
27	Predator loss	Old	3	Between heavily-grazed plants of three-awn[b] and shinnery oak.
28	Abandoned	Old	3	Between heavily grazed plants of three-awn, shinnery oak[b], and dropseed.
29	Predator loss	Old	1	Between moderately grazed clumps of little bluestem[b].

Number	Success	Age of Cover[a]	Subtype	Nest Placement
30	Hen killed by predator	Current (leaves)	2	Between ungrazed clumps of shinnery oak[b].
31	Abandoned	Current (blades)	3	Beside ungrazed yucca[b] plant.
32	Predator loss	Current (leaves)	1	Beside ungrazed shinnery oak[b] plant.
33	Abandoned	Current (leaves)	2	Between ungrazed shinnery oak[b] plants.
34	Predator loss	Mostly current; some old	3	Under ungrazed sand sage-brush[b] plant.
35	Abandoned	Old	2	Between heavily grazed three-awn[b] and shinnery oak plants.
36	Predator loss	Old	2	Between heavily grazed three-awn[b] and shinnery oak plants
37	Successful	Old	2	Beside lightly grazed clump of little bluestem[b].
38	Predator loss	Mostly current; some old	2	Between ungrazed sage-brush[b] and three-awn plants.
39	Successful	Old	1	In lightly grazed clump of sand bluestem[b].

[a]Old cover refers to vegetation that is growth still standing from previous years. Current cover refers to vegetation that grew during the year of the nest.

[b]Principal overhead cover at the nest.

Appendix V. Common names, orders, and families of animals found in crop contents, after Borror and White (1970).

Common Name	Order	Family
<u>Arachnids</u>		
Spider	Araneida	Unidentified
<u>Insects</u>		
Ant	Hymenoptera	Formicidae
Caterpillar	Lepidoptera	Unidentified
Click beetle	Coleoptera	Elateridae
Cockroach	Orthoptera	Blattidae
Cricket	Orthoptera	Gryllidae
Darkling beetle	Coleoptera	Tenebrionidae
Fly	Diptera	Unidentified
Ground beetle	Coleoptera	Carabidae
Leaf beetle	Coleoptera	Chrysomelidae
Long-horned grasshopper	Orthoptera	Tettigoniidae
Mantid	Orthoptera	Mantidae
Moth	Lepidoptera	Unidentified
Robber fly	Diptera	Asilidae
Scarab beetle	Coleoptera	Scarabaeidae
Scentless plant bug	Hemiptera	Corizidae
Shield-backed bug	Hemiptera	Scutelleridae
Short-horned grasshopper	Orthoptera	Acrididae
Silken fungus beetle	Coleoptera	Cryptophagidae
Snout beetle	Coleoptera	Curculionidae
Treehopper	Homoptera	Membracidae
Walking stick	Orthoptera	Ohasmatidae
Weevil	Coleoptera	Curculiondae

Appendix VI. Diet in fall of 1976, and in fall of 1977.

Appendix Table 1. Percent composition of the diet in fall[a] 1976[b].

Food Item	Mean	Standard Deviation
Mast and Seeds		
Shinnery oak acorns	61.6	38.1
Spurge seeds	4.4	6.7
Total Mast and Seeds	66.0	39.0
Vegetative Material		
Insect galls from shinnery oak	13.5	24.7
Dwarf dalea (leaves)	5.9	15.0
Downy phlox (leaves)	3.9	5.8
Spurge (leaves)	2.8	
Shinnery oak (leaves)	1.3	
Unidentified leaves	t[c]	
Total Vegetative Material	27.4	41.3
Animals		
Crickets	2.9	
Caterpillars	1.9	
Short-horned grasshoppers	1.8	4.1
Treehoppers	t	
Spiders	t	
Total Animals	6.6	10.8

[a]October through December.

[b]Contents of crops from 9 birds.

[c]Trace (less than 0.1 percent).

Appendix Table 2. Percent composition of the diet in fall[a] 1977[b].

Food Item	Mean	Standard Deviation
Mast and Seeds		
Shinnery oak acorns	16.8	28.4
Narrowleaf gromwell seeds	3.7	
Spectacle pod seeds	t[c]	
Total Mast and Seeds	20.5	28.1
Vegetative Material		
Broom groundsel (leaves)	12.9	25.0
Dwarf dalea (leaves)	6.8	9.8
Wildbuckwheat (shoots)	5.9	11.1
Insect galls from shinnery oak	5.4	6.9
Narrowleaf gromwell (leaves)	3.9	
Composite (buds)	3.8	
Evening primrose (leaves)	3.6	
Bitterweed (leaves)	1.9	
Shinnery oak (leaves)	1.6	
Broom snakeweed (leaves)	1.2	
Wildbuckwheat (leaves)	1.1	
Spurge (leaves)	1.1	
Buckley penstemon (leaves)	0.7	
Total Vegetative Material	49.9	38.4
Animals		
Short-horned grasshoppers	27.5	33.8
Long-horned grasshoppers	0.6	
Ground beetles	0.4	
Crickets	0.3	
Shield-backed bugs	0.3	
Scentless plant bugs	0.3	
Walking sticks	0.1	
Unidentified beetles	0.1	
Total Animals	29.6	33.9

[a]October through December.

[b]Contents of crops from 17 birds.

[c]Trace (less than 0.1 percent).